

Report of the Biological Survey of Mutsu Bay_3. Notes on the Protozoan Fauna of Mutsu Bay. I. Peridiniales.

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Report of the Biological Survey of Mutsu Bay.*

3. Notes on the Protozoan Fauna of Mutsu Bay.

I. Peridiniales.

By

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The investigation of the plankton of Mutsu-Bay carried on last August at the Asamushi Marine Biological Station has brought to light a rich protozoan fauna in which the Dinoflagellates are abundant. The material, as will be surmised from the conditions of the oceanic currents in the Tsugaru Strait, is comprised partly of a number of warm temperate water species and partly of those of cold temperate seas.

The present paper includes only the majority of the Peridiniales observed during my sojourn at the station last August. The rest of them and of other classes will be given in later papers. Not only the new forms which came to light in my investigations, but also the other species which have already been reported from warm and cold temperate seas in other parts of the world are figured, and some of them are fully re-described here. The difficulty in getting adequate literatures in this country forced me, to my great regret, to leave some, which seem to me recommendable, unidentified. The references under each species in this paper are those for which I have been able to see some figures concerning the species even though the original papers for the species whether I could or could not get. Of late years several different methods of designating the plates of the genus *Peridinium* have been proposed. The designating method used in this paper is BROCH's (1910) which was partly modified by ROVIGNO and PAULSEN (1911) (Fig. 14). For the necessity of denoting the antapical intercalary plates of another genus, I used in this paper φ , χ and ω , and

* A contribution from the Marine Biological Station, Asamushi, Aomori-Ken.

the first figure denoting each series of plates was put on the right shoulder of numerals, as, 7² or 3¹ to indicate the number of plates comprised in the series.

Grateful acknowledgement is here made to Professor S. GOTO, of Tokyo Imperial University, for his kind advice to commence and continue this work, to Professor S. HOZAWA, of Tohoku Imperial University, for collecting material and supporting this work, and also to Professor S. HATAI, of Tohoku Imperial University, the Director of the Institute, for the permission to use the research table and for getting some reagents and apparatus from Sendai.

My sincere thanks to Professor M. KOIDZUMI, of Keio University, to Professor T. KABURAKI, of Tokyo Imperial University, and to Professor K. OKAMURA and H. MARUKAWA, of the Marine Fisheries Bureau for advice and kind help in getting literature, and also to Assistant Professor S. KOKUBO, to Assistant S. TAKATSUKI, and to Assistant Y. KAMADA, of the Asamushi Marine Biological Station, for collecting material.

Asterisks (*) were used through out the entire pages to refer to those works which I could not read the original papers.

DINOPHYSIS EHRENBURG.

1) *Dinophysis intermedia* PAVILLARD (?).

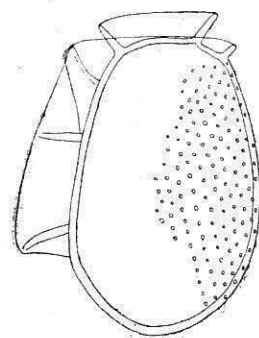


Fig. 1. *Dinophysis intermedia*
PAVILL. (?) ($\times 600$)

*PAVILLARD 1916, p. 58, Pl. III, Fig. 4.
FORTI 1922, p. 110, Pl. VII, Fig. 119.

An elongated egg-shaped species with deep cups composed of singular lists, and a rounded posterior end. The ratio of the length to the breadth is 0.32, and the widest part is about $\frac{2}{3}$ from the anterior end.

Dimensions: Length, 57μ ; transdiameter, 31μ .

Loc. Yunoshima, Aug. 16, 1926.

2) *Dinophysis rotundata* CLAPARÈDE et LACHMANN.

**D. rotundata* CLAP. et LACHM., 1859, p. 409, Pl. XX, Fig. 16.

SCHÜTT 1895, Pl. I, Fig. 5.

PAULSEN 1908, p. 17, Fig. 18.

Body is broad oval in side view, with bilateral flattening. The ratio of the length to the breadth is 0.9. The plasma is light brownish yellow in colour.

Dimensions: Length, 53μ ; transdiameter, 48μ .

Loc. Off Hadakaiwa, Aug. 14, 1926.

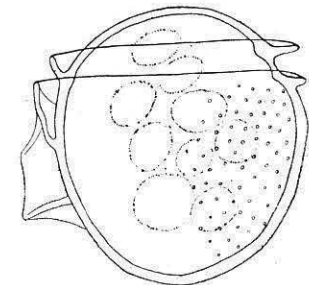


Fig. 2. *Dinophysis rotundata*
CLAP. et LACH. ($\times 600$)

PHALACROMA STEIN.

3) *Phalacroma mitra* SCHÜTT.

SCHÜTT 1895, Pl. IV, Fig. 18.

SCHÜTT 1896, p. 26, Fig. 38.

OKAMURA 1907, p. 134, Pl. V, Fig. 43.

FORTI 1922, p. 105, Pl. VII, Fig. 109.

Dimensions: Length, 64μ ; transdiameter, 55μ ; dorsoventral diameter, 44μ .

Loc. Yunoshima, Aug. 8, 1926.

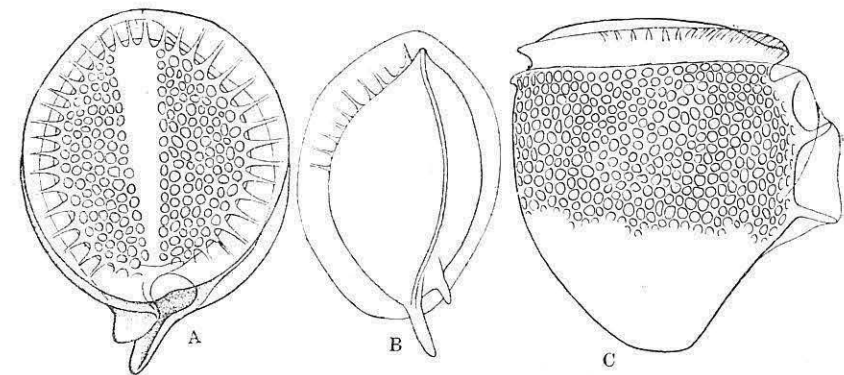


Fig. 3. a. *Phalacroma mitra* SCHÜTT.
A. Apical polar view. B. Antapical polar view. C. Side view.

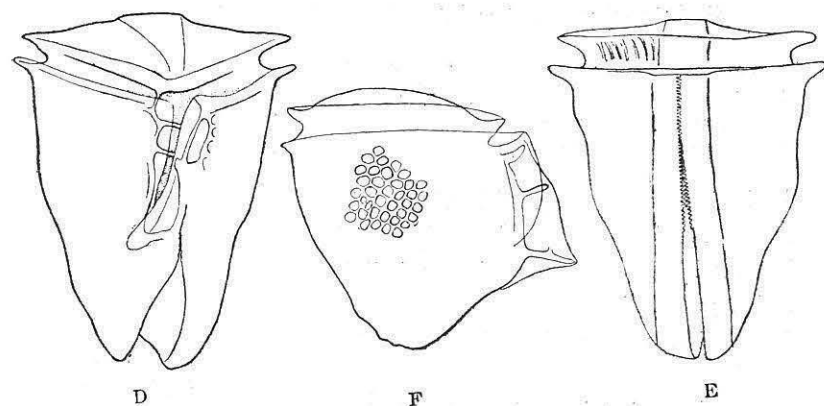


Fig. 3. b. D, ventral view. E, Dorsal view. F, Side view of another smaller specimen with a somewhat deformed contour. ($\times 600$)

DIPLOPSALIS BERGH.

4) *Diplopsalis lenticula* BERGH.

BERGH 1881, p. 244, Figs. 60-62.

SCHÜTT 1895, Pl. XV, Fig. 50.

SCHÜTT 1896, p. 21, Fig. 31.

OKAMURA 1907, p. 131, Pl. V, Fig. 44.

PAULSEN 1908, p. 35, Fig. 44.

The ventral area is short, flaring slightly posteriorly, guarded with a well developed list on its left and posterior rims.

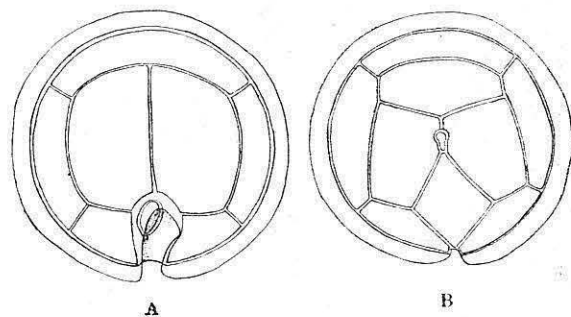


Fig. 4. *Diplopsalis lenticula* BERGH.

A and B, Diagrams of plates on the hypotheca and the epitheca. ($\times 600$)

Dimension: Transdiameter, 43μ .

Loc. Off Hadakaiwa, Aug. 10, 1926.

5) *Diplopsalis lenticula* BERGH var. (?).

This differs from the preceding species in having only one antapical plate and in its smaller size. The ventral area is somewhat larger than the type species and is elongated obliquely and posteriorly to the left, along which left rim exhibits a broader list, but not extending to the posterior rim.

Dimensions: Length, 51μ ; transdiameter, 45μ .

Loc. Off Asamushi, Aug. 10, 1926.

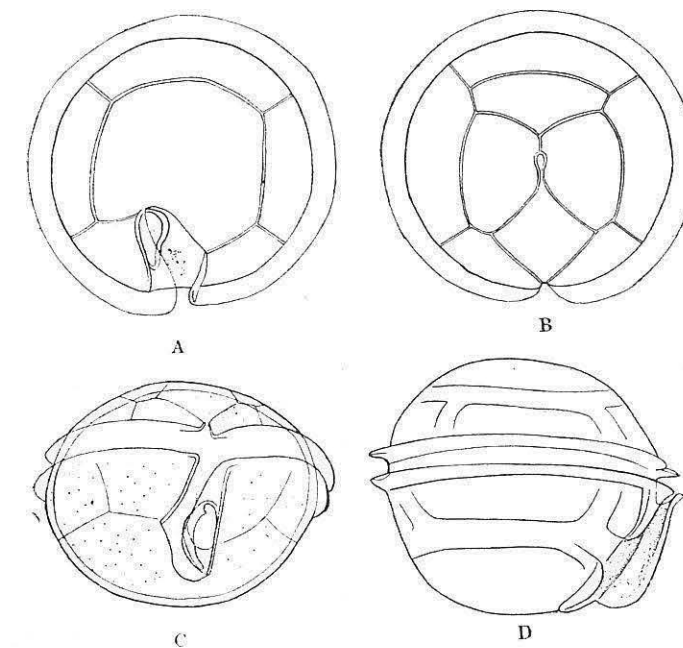


Fig. 5. *Diplopsalis lenticula* BERGH var. ?

A and B, Pattern of the plates the hypotheca and the epitheca. C, Ventral view. D, Side view. ($\times 600$)

GONYAULAX DIESING.

6) *Gonyaulax polygramma* STEIN.

*STEIN 1883, Pl. IV, Fig. 15.

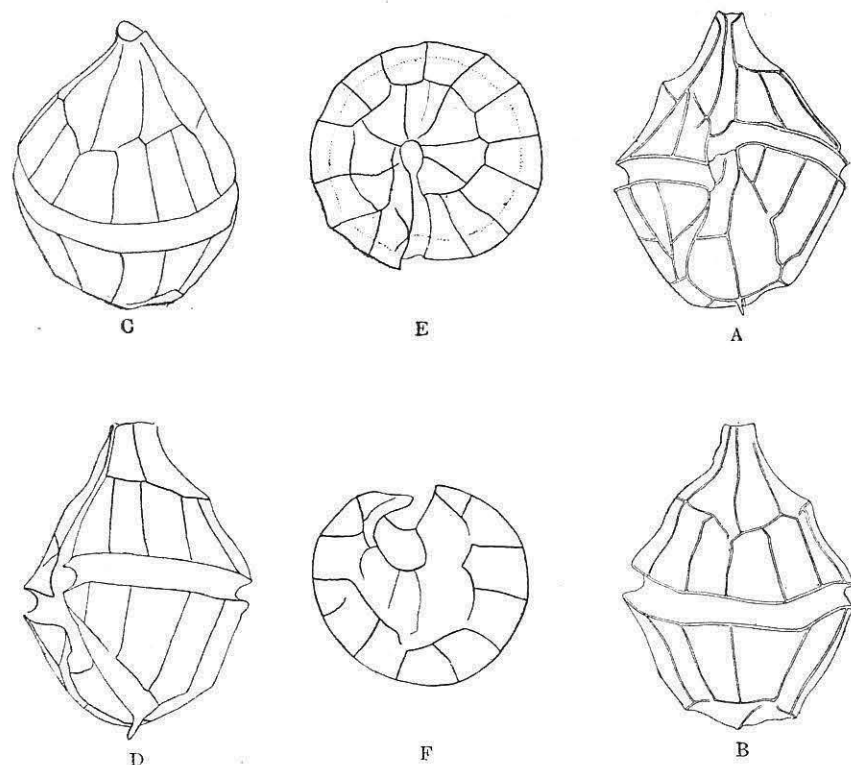
SCHÜTT 1895, Pl. IIX, Fig. 33.

OKAMURA 1907, p. 132, Pl. III, Fig. 13.

PAULSEN 1908, p. 29, Fig. 36.

KOFROID 1911(a), p. 229, Pl. X, Figs. 6-7, Pl. XVII, Fig. 47.

A medium-sized, somewhat elongated species with longitudinally striated and reticulated surface. Body is rugged oval with both shoulders angled at the apical-precingular and postcingular-antapical sutures,

Fig. 6. *Gonyaulax polygramma* STEIN.

A, Ventral view. B, Dorsal view. C, Dorsal right-side view. D, Ventral left-side view. E and F, Apical and antapical view of a specimen showing the arrangement of the longitudinal ribs. ($\times 600$)

bearing one or two small antapical spines. The longitudinal ribs vary in number and arrangement, but some of them are more or less exactly on the suture lines, so that it is possible to distinguish the thecal order from the arrangement of the ribs. The plasm is dark yellowish green.

Dimensions: Length, 57μ ; transdiameter, 45μ ; dorsoventral diameter, 42μ .

Loc. Off Hadakaiwa, Aug. 10, 1926.

7) *Gonyaulax spinifera* (CLAP. et LACHM).

PAULSEN 1908, p. 29, Fig. 37.

KOFROID 1911(a), p. 209, Pl. X, Figs. 8-10, Pl. XVI, Fig. 39, Text-fig. A-D. (?)

G. mangini FAURÉ-FREMIET 1908, p. 230, Fig. 16.; Pl. XVI, Fig. 19.**Peridinium spiniferum* CLAP. et LACHM., 1895, p. 405, Pl. XX, Figs. 4, 5.

A minute species with a broad spiral girdle and an antapical horn, closely corresponding to *G. mangini* F. F. judging from the figure and descriptions given by the author.

Body is somewhat short and egg-shaped. The epitheca is subconical with a short apical horn. The girdle is very broad and median, with well developed lists of the body wall. The furrow is deeply impressed, and descending, and is displaced distally 3 girdle widths, and overlaps one of its widths. The groove connecting its two ends is narrow but is deeply impressed. The ventral area is a narrow furrow, curved somewhat obliquely to the right.

The hypotheca is a flat hemisphere, with a short but distinct antapical spine on its apex at the right post-margin of the longitudinal groove.

It is quite probable that *G. monoacantha* PAVILL is closely related to this species in its general features except in its large, distinct, apical horn.

Dimensions: Length, 27μ ; transdiameter, 22μ .

Loc. Off Asamushi, Aug. 21, 1926.

Fig. 7. *Gonyaulax spinifera* DIESING.

Ventral view. ($\times 600$)

8) *Gonyaulax polyedra* STEIN.

*STEIN 1883, p. 13, Pl. IV, Figs. 7-9.

PAULSEN 1908, p. 31, Fig. 40.

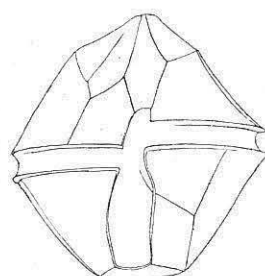


Fig. 8. *Gonyaulax polyedra*
STEIN. ($\times 600$)

KOFOID 1910, p. 238, Pl. XII, Figs. 16-20; Pl. XIV, Figs. 28, 29, 31; Pl. XVII, Fig. 43.
CONRAD 1926, p. 95, Pl. II, Fig. 37.

A medium-sized species. The body is pentagonal with a truncated posterior end.
Dimensions: Length, 34μ ; transdiameter 36μ .

Loc. Off Futagojima, Aug. 23, 1926.

9) *Gonyaulax turbynei* MURRAY and WHITTING.

MURR. and WHITT. 1899, p. 323-324, Pl. XXIX, Fig. 4.
KOFOID 1911(a), p. 225, Pl. XVII, Fig. 44.
FORTI 1922, p. 80, Pl. VI, Fig. 67.

A small, ovoid species without a distinct apical horn. The surface is striated with pores which are sparsely but more or less longitudinally scattered, and the inter-striae regions are markedly reticulated.

Dimensions: Length, 40μ ; transdiameter, 34μ .

Loc. Yunoshima, Aug. 16, 1926.

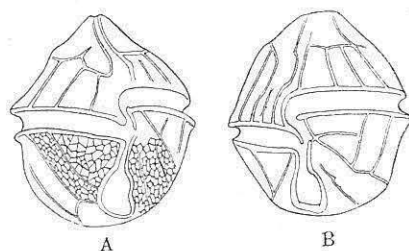


Fig. 9. *Gonyaulax turbynei* MUR. and WHITT.

A and B, Ventral views of two specimens. ($\times 600$)

PYROPHACUS STEIN.

10) *Pyrophacus horologicum* STEIN.

*STEIN 1883, Pl. XXIV, Figs. 1-13. Pl. XXV, Fig. 1.
BÜTSCHLI 1885, Pl. LIV, Fig. 3.
SCHÜTT 1895, Pl. XVII, Fig. 51.
SCHÜTT 1896, p. 13, 15, Figs. 17, 21.
PAULSEN 1908, p. 67, Fig. 89.

A large, flattened species. The number of plates are roughly proportional to its size, larger ones having a larger number of plates,

and smaller ones a smaller number of plates. The specimen shown in Fig. 9, A and B is one having probably a minimum number of plates.

Dimensions: Length, $103-134\mu$; transdiameter, $94-124\mu$.

Loc. Off Asamushi, Aug. 16, 1926.

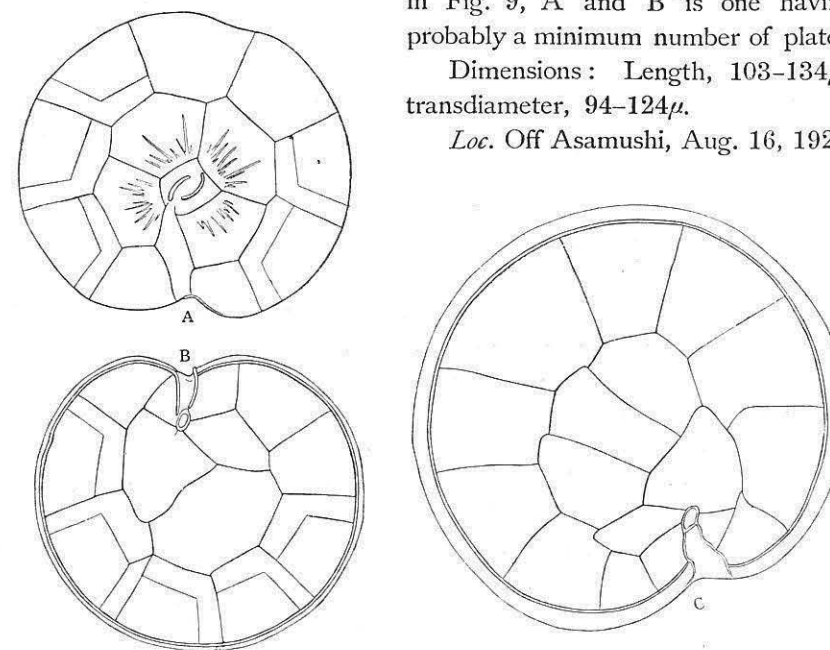


Fig 10. *Pyrophacus horologicum* STEIN.

A and B, Arrangement of the plates on the epitheca and the hypotheca of one specimen, having probably a minimum number of plates. C, The hypotheca of another larger specimen showing a larger number of plates. ($\times 280$)

SPHAERIDINIUM WOLOSZYNSKA.

11) *Sphaeridium asymmetria*, n. sp.

A minute, spheroidal species with a somewhat curved ventral area, a relatively wide girdle, and no apical nor antapical processes.

The body is spherical. The epitheca and the hypotheca are both hemispherical. The most conspicuous character of this species is a distinct diagonal suture ridge on the epitheca from the left ventral to the right dorsal, crossing the apical pore. It is incomplete as it is only within the area of the apical and the intercalary plates, not extending into the precingular series which is only poorly developed.

It, then, divides the plates, though incompletely, into two groups, the apical α , β , and γ , and the intercalary δ in the ventral, and the apical β and the intercalary δ , ϵ , in the dorsal half. Having some relation with the obliquity of the ridge, the plates of the right ventral and the left dorsal regions are larger or more extended than those of the left ventral and the right dorsal parts so that the apical plate β is smaller than the plate γ , and the precingulars a and b are much smaller than the corresponding plates g and f . Of these the first surely is the smallest in the epitheca. The intercalary plate δ is the largest one, and the others, γ and ϵ , show a slight difference in size, but they are markedly displaced to the left side of the body by the asymmetrical development of the apical and the precingular plates. The precingular c is a very low but wide quadrangular plate. The apical pore is relatively large with a little smaller pore-like ventral slit. The slit is not accurately in the ventral median side, but is deflected about 45° to the right side of the body from the dorso-ventral median plane. It also makes an angle of about 60° with the diagonal suture ridge. The girdle is broad and median. The furrow is not deeply impressed, and is very slightly ascending without marked side-lists. The ventral area curves to the left and then to the right in sausage shape, bearing a semi-lunar list on its posterior right side. It is deeply impressed in the anterior part and along the right edge of the post-girdle part of the area, of which the middle portion is covered with the hyaline semi-lunar list. The hypotheca is hemispherical, as stated above. Its plate formula is 5^4 , 2^1 , and 2^2 . As will be clearly recognized in the text figures, one small, elongated plate, z , is seen at the right of the incurved right rim, and a minute semi-lunar plate, ϕ , at the rear of the posterior edge of the ventral area. These small, hypothecal, intercalary plates, with the epithecal diagonal ridge, keep this species aloof from any other species of *Peridinium*. The surface is smooth and the plasm is colourless. The suture lines, excluding the ridge, are very narrow and indistinct, being recognized in some specimens only with the oil immersion.

This species is distinguished at once from *Peridinium globulus* and *P. minutum*, by its rounded apex. The curved ventral area and the irregularly displaced thecal plates serve to separate it from *P. sphericum* MURR. & WHITT. The ventral area of this species has some similarities

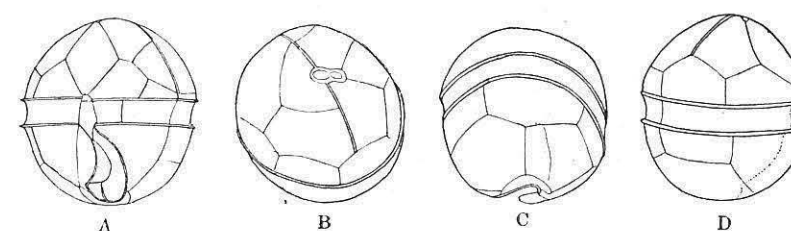


Fig. 11. *Sphaeridium asymmetria*, n. sp.

A, Somewhat oblique ventral view. B, Oblique apical view. C, Oblique dorsal view of the hypotheca. D, Right side view. ($\times 600$)

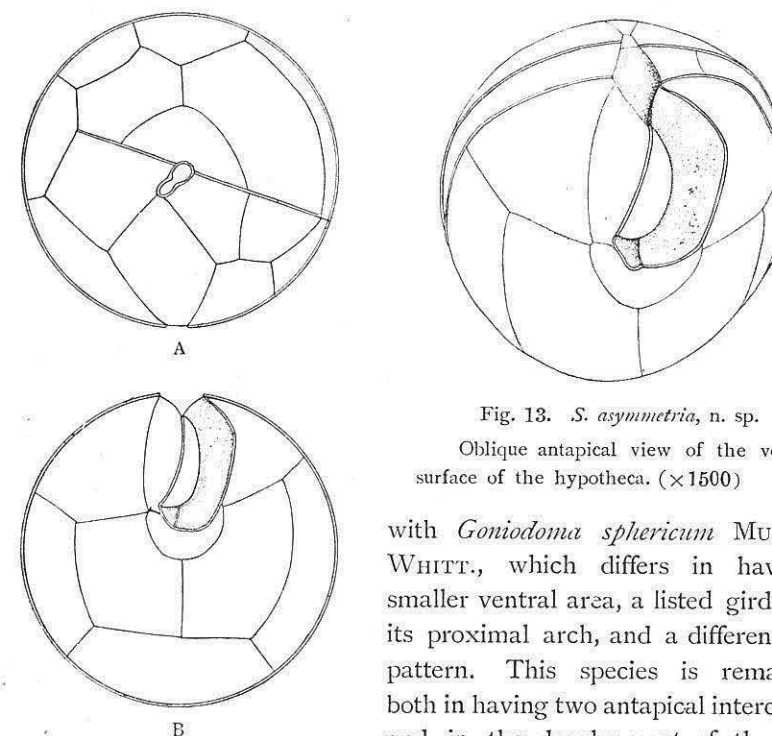


Fig. 12. *S. asymmetria*, n. sp.

A and B, Diagrams of the plate arrangement of the epitheca and the hypotheca. ($\times 1500$)

Fig. 13. *S. asymmetria*, n. sp.

Oblique antapical view of the ventral surface of the hypotheca. ($\times 1500$)

with *Goniidoma sphericum* MURR. & WHITT., which differs in having a smaller ventral area, a listed girdle with its proximal arch, and a different plate pattern. This species is remarkable both in having two antapical intercalaries and in the development of the apical diagonal band, as well as in the structure of the ventral area. It is not closely related structurally to any other species in the genus *Peridinium*, and its separation to the genus *Sphaeridium* is justified mainly on the

ground of its spherical body without girdle lists or any appendages except the ventral fin, and also on its antapical intercalary plates. The anterior antapical intercalary plate ought not to be regarded as a post-cingular plate, but must be separated into another series, the antapical intercalary series, with the minute posterior plate, from the view point of its development, so that the plates of the hypotheca consist of 5 precingular, 2 antapical, and 2 intercalary plates. The absence of one apical intercalary plate and the excess of one plate in the antapical intercalaries make it doubtful as to whether this species really deserves to be separated in the genus *Sphaeridinium* or not.

Dimensions: Length 36μ ; transdiameter, 34μ .

Loc. Off Asamushi, Aug. 15, 1926. Very rare.

PERIDINIUM EHRENBURG.

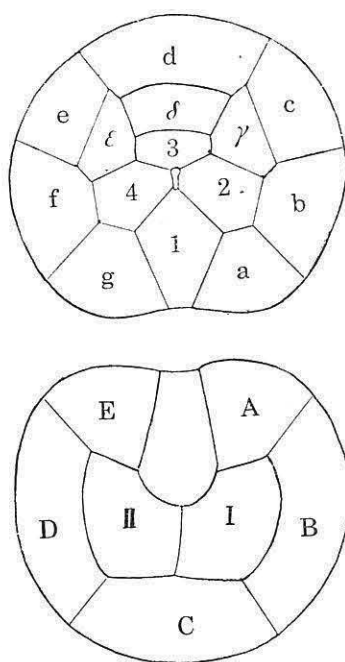


Fig. 14.

BROCH's modified method of denoting thecal plates.

Upon attempting to arrange the vast divergencies of the morphological variations in the genus, early observers, SCHÜTT, BERGH, and GRAN divided the genus into two subspecies, *Protoperidinium* and *Euperidinium*, according to the anterior displacement of the girdle, coupled with the solid antapical horns for the former, and the posterior displacement of the girdle together with the hollow antapical horns for the latter. But in later year another system was proposed by JØRGENSEN (1912) on the basis of plate relationships, which was confirmed by BARROWS (1918), though criticized and somewhat modified by PAVILLARD (1916). BARROWS divided the genus into three groups, giving the name *Orthoperidinium* to those species having the ventral plate pattern of *P. achromaticum*, *Metaperidinium* to these

having that of *P. pellucidum*, and *Paraperidinium* to those having the plate pattern of *P. spherioidea*. In the former system the main emphasis is placed upon the structures of the girdle and the antapical horn, but in the latter it is based only on the plate pattern without considering any of the characters of the appendages and the girdle. It would be convenient if the two systems were used together to denote the characters of the species, and the two are not unimportant in dividing the genus, each designating the different structural characters.

12) *Peridinium orbiculare* (PAULSEN) var. *temaris*, n. var.

A small, spherical species without elevation of the apical horn, or antapical spines.

The epitheca is subhemispherical. The plates are of the *Orthoperidinium* type. The plates of the apical are well developed. The girdle is median, is relatively wide and ascending, and is displaced distally half its width. The furrow is not impressed, bearing low side-lists. The section at the girdle is circular. The ventral area is narrow and short, guarded by a broad, hyalinous, crescent fin on its left side, not extending to the posterior extremity. The hypotheca is also subhemispherical without post-indentation, or antapical spines. The antapical plates are large. A small, somewhat triangular, intercalary plate is on the right side of the ventral area as well as five postcingulars. The surface is smooth. The intercalary bands are wide and are provided with distinct transverse striations.

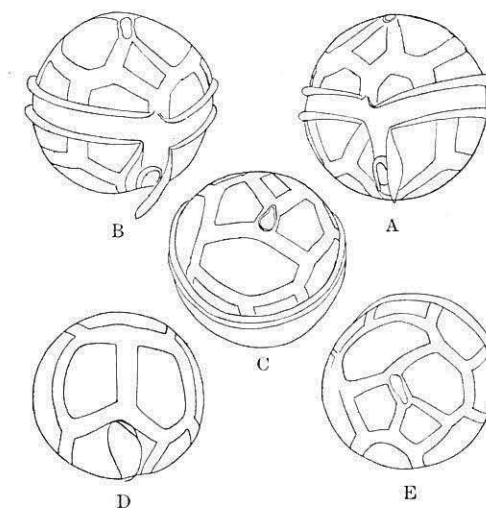


Fig. 15. *Peridinium orbiculare* (PAULSEN) var. *temaris*, n. var.

A, ventral view. B, Oblique ventral view. C, Dorso-apical view. D, Antapical view. E, Antapical view of the epitheca. ($\times 600$)

The lacking of one dorsal intercalary plate in this variety serves to separate this from the atlantic species.

Dimensions: Length, 35μ ; transdiameter, 34μ .

Loc. Off Futagojima, Aug. 23, 1926.

13) *Peridinium nipponica*, n. sp.

A small, spherical species with a short apical horn and four delicate antapical spines.

The body is spherical without any ventral flattening. The girdle section is circular and is perpendicular to the body axis. The apical pore is at the terminal of the small apical horn with a short ventral slit. The thecal plates are of the *Paraperidinium* type with three intercalary plates. The epitheca is hemispherical, symmetrical with the hypotheca. The apical plate r is a large hexagonal. The precingulars b and f are the largest in the series, while the dorsal d is a flat plate. The dorsal, hexagonal, intercalary δ is as large as the plate b , but the other two pentagonals, γ and ϵ , are the smallest in the epitheca. The intercalary bands are wide. The girdle is median and is relatively narrow, with hyaline side-lists. The furrow is circular and is faintly impressed. The ventral area is spoon-shaped, comprising anterior narrow and posterior wider portions. The flagellar pore is in the left corner of the posterior wider portion, the ventral and the dorsal rims of which bear two short spines. Two other longer spines are seen on the postero-lateral edges of the area, all of them having no side-fins except the short ventral one. A longitudinal fin is on the left side of the ventral area connecting the short, dorsal spine and the proximal part of the posterior girdle list. The longer spine is 0.33 times that of transdiameter. The surface is smooth except the intercalary bands, which are faintly striated transversely. The plasm is colourless. A closely resembling species, *P. sphericum*, was reported off the coast of Tosa, Shikoku, by Okamura, but differs from this species in its larger size, slightly ascending girdle, and two finned antapical spines.

It is closely related to *P. ovum* in general, but differs in thecal plates and some structures in the posterior region of the ventral area.

Dimensions: Length, 40μ ; transdiameter, 36μ .

Loc. Off Asamushi, Aug. 16, 1926.

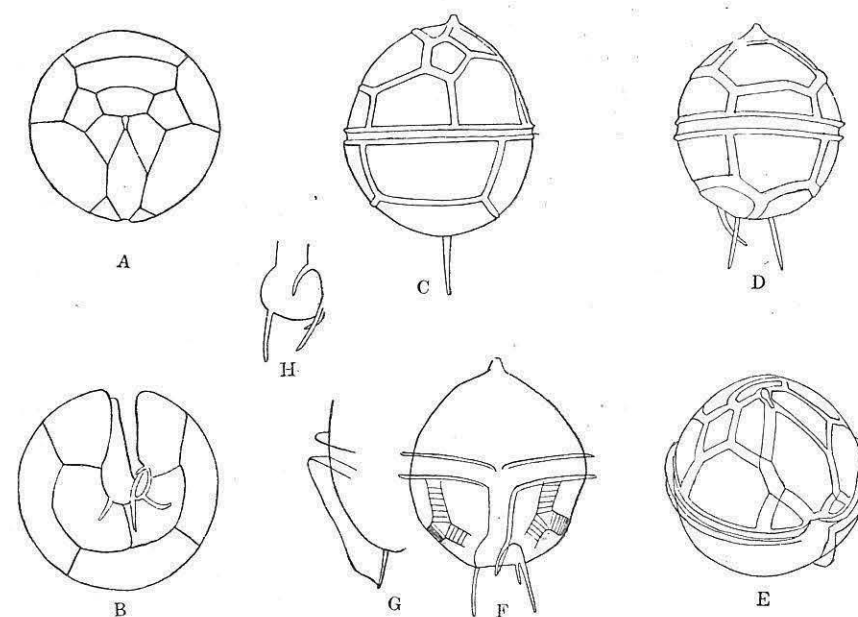


Fig. 16. *Peridinium nipponica*, n. sp.

A and B, Diagrams of the plates on the epitheca and the hypotheca. C, Side view. D, Dorsal view of another specimen. E, Oblique polar view of the specimen. F, Ventral view of another one. G, Side view of the longitudinal fin of the ventral area. H, Oblique antapical polar view of the posterior ventral area, showing the four spines. ($\times 600$)

14) *Peridinium spherioidea*, n. sp.

A small, spherical species with two finned antapical spines and broad girdle lists. The body is spherical without ventral flattening, so that both the epitheca and the hypotheca are hemispherical. The apical horn is small and flat, hard to detect. The apical pore is small with a short ventral furrow. There seems to be a ventral slit, but close observation proves it to be not a slit but a groove. The intercalary bands are broad and transversely striated. The plates are of the *Metaperidinium* type with three intercalaries. The apical r is a large hexagonal plate, but the dorsal plate z is small. The lateral intercalary plates γ and ϵ are small, and the dorsal δ is somewhat larger. The ventral precingular a and g are minute, triangular plates. The girdle

is ascending and is displaced distally 1.5 its width, with a proximal arch. The furrow is relatively narrow, faintly depressed, with broad side lists bearing abundantly ribbed fins on their inner sides. Short, numerous, perpendicular wrinkles, their length being shorter than one-third of the girdle breadth, are observed along both sides of the groove, which are only the traces of the rib's bases in the lists. The girdle plane is not perpendicular to the body axis, but is inclined about 15° from the perpendicular plane. The ventral area is a narrow groove guarded with side fins. The right side fin is a little narrower than the left, while the left one is broad and curves inwardly, spreading over and nearly covering the left half of the area. The flagellar pore is in the left side, near the truncated posterior margin, of the area. Two long, antapical spines, each with three lateral fins are on the antapex of the hypotheca, one on the right corner of the truncated post-margin of the ventral area, and the other on its left edge a little distance from its left corner. The left spine inclines ventrally. The left antapical plate 1 is smaller than the right one. The surface is smooth.

Three spine-like processes are observed at the antapex in ventral view, but the shorter left one is not really a spine, but merely an image caused by the lengthwise view of the posteriorly thickened part of the side fin at the intersection of this with the left median fin of the spine, which is not noticed in side view.

This species is distinguished at once from *P. globulus*, by its different thecal arrangement and in having antapical spines. *Peridinium cerasus*, and *P. orbiculare* are distinguished from this by their smaller size, and its antapical spines serves to separate this from *P. orbiculare*. *Peridinium sphericum* OKAMURA is one of the best related species, but differs in its much smaller size, in having the equatorial girdle plate perpendicular to the body axis and in having a distinct apical horn. On the other hand, the distal displacement of the girdle, the shorter but spreading left antapical spine and the broad side list on the left edge of the ventral area show the close relation of the two. OKAMURA's non-detailed figures and descriptions make it difficult to identify it with this species, and it is quite probable that they are two different species.

Dimensions: Length, 62μ ; transdiameter, 58μ ; dorso-ventral diameter, 54μ .

Loc. Off Futagojima, Aug. 28, 1926.

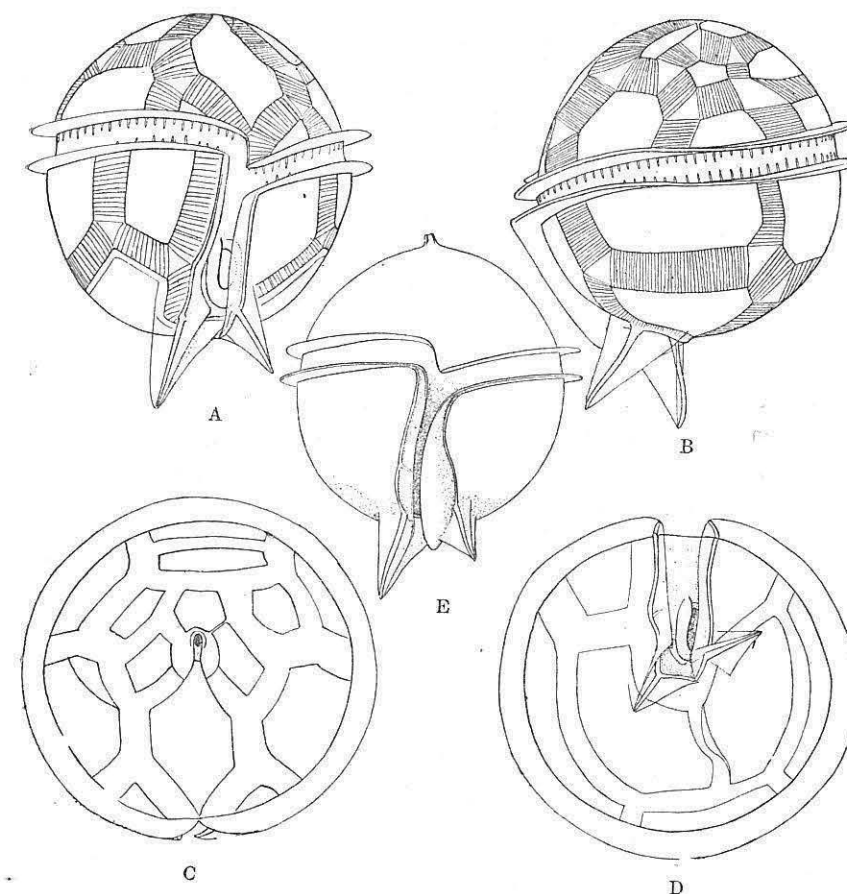


Fig. 17. *Peridinium spheroides*, n. sp.

A, Antapical ventral view. B, Side view. C and D, Pattern of the plates of the epitheca and the hypotheca. E, Ventral view of another smaller specimen. ($\times 600$)

15) *Peridinium hirobis*, n. sp.

A minute species with an extraordinarily wide girdle and two antapical spines. The epitheca is subhemispherical, the anterior surface of which is contracted to a short apical horn. The plates are of the *Metaperidinium* type with three dorsal intercalaries. Its cross-section at the girdle is broad oval. The girdle is post-median, and is very

wide, with ribbed lists. Its proximal part is far wider than the distal part. The furrow is not deeply impressed, and is slightly ascending distally. The ventral area is also wide, widening posteriorly, guarded with a broad fin on its left side. The flagellar pore of this species is very large, is elongated along its left side and extends anteriorly to the post-margin of the proximal girdle end. The hypotheca is a flat subhemisphere with a shallow post-indentation at the post-margin of the ventral area. In addition to the two long antapical spines, slightly diverging posteriorly, a short spine is seen on the inner side of the left spine in the ventral view. It is not a spine, but an image formed by the posterior extension of the side list. The surface is smooth and the intercalary bands are narrow and indistinct.

Dimensions: Length, 26μ ; transdiameter, 24μ ; dorsoventral diameter, 22μ .

Loc. Off Futagojima, Aug. 23, 1926.

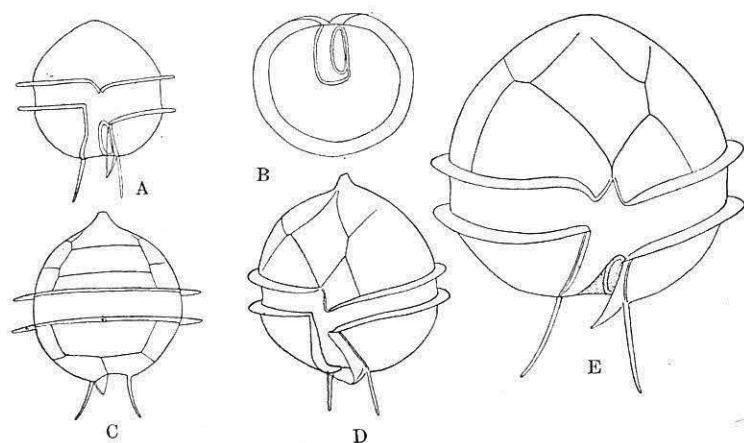


Fig. 18. *Peridinium hirobis*, n. sp.

A, Ventral view of a smaller specimen with a broken apical part. B, Antapical view. C, Dorsal view of another larger one. D, Oblique ventral view. ($\times 600$) E, Ventral view of a different, imperfect specimen. ($\times 1500$)

16) *Peridinium pellucidum* (BERGH).

SCHÜTT 1895, Pl. XIV, Fig. 45.

AURIVILLIUS 1898, p. 98.

PAULSEN 1908, p. 49, Fig. 61.

BROCH 1910, p. 188, Fig. 6.

Protoperidinium pellucidum BERGH 1881, p. 227, Figs. 46-48.

A small, globular species with a tapering apical horn, two somewhat thick antapical spines and a broad girdle.

The epitheca exceeds the hypotheca. The epitheca is subhemispherical, the side of which contracts gradually into a short apical horn, bearing a long ventral slit along its ventral anterior end. The plates are of the *Metaperidinium* type with three intercalaries. It is nearly circular at the girdle. The girdle is broad, not impressed, bearing wide, coarsely ribbed lists. It is ascending, and is displaced distally half its width. The ventral area widens somewhat posteriorly, invading deeply, posteriorly, the antapical plates. The furrow is deeply excavated, its posterior margin much indenting the antapex. It is guarded with a broad lunar fin on its left side. The hypotheca is subhemispherical with two antapical spines on its antapex. The spines are subequal, often provided with fins along their whole length or at basal parts alone, their basal parts, thickening proximally, abruptly merge into the body contour. The surface is smooth. The intercalary bands are narrow but distinct. A minute pore-like figure is observed in the band anterior to the anterior plate of the ventral area. The thecal wall is thin.

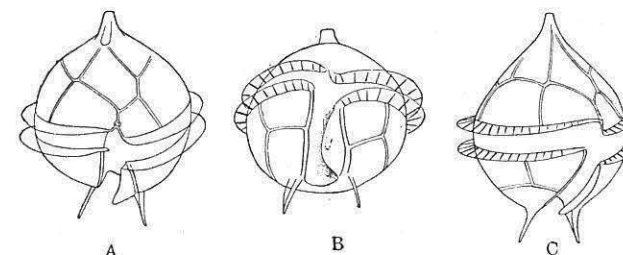


Fig. 19. *Peridinium pellucidum* (BERGH)

A, Ventral view. B, Ventral antapical view. C, Right ventral view. ($\times 600$)

The apical horn of this species is shorter and less distinctly differentiated than that of *P. steini*, but is more pronounced than *P. breve*. Of this species, the apical horn is more slender, the body is larger and somewhat elongated (the ratio of breadth to length is 1.3)

than those of BROCH's Val di Bora specimens to which it is most closely related.

Dimensions: Length 34μ (including apical horn); transdiameter, 31μ .

Loc. Off Futagojima, Aug. 23, 1926.

17) *Peridinium okamurai*, n. sp.

P. pallidum PAULSEN var (?), OKAMURA 1912, p. 14, Pl. IV, Fig. 70.

A small, elongated, pear-shaped species with a short apical horn and two finned antapical spines.

The body is slightly dorso-ventrally compressed. The epitheca has convex sides which contract abruptly to a short apical horn. The apical pore bears a wide but short ventral slit. The plates are of the *Paraperidinium* type with three intercalary plates. The dorsal intercalary plate δ is larger than the apical β , and its surface in some specimens is markedly convex so as to form a hump in the middle of the dorsal side. Consequently, the apical plate α can not be observed in the apical view of the epitheca, being hidden under the hump in such a specimen. The girdle is post-median and ascending, and is displaced distally one girdle width. The furrow is not deeply impressed, bearing broad, well developed, ribbed side lists with a large rib at each of the bases of the longitudinal intercalary bands. The ventral area is narrow without posterior widening, guarded with the left broad and right low side lists. It noticeably indents the antapicals. The section at the girdle is broad oval without distinct ventral flattening. The hypotheca is rounded posteriorly with a narrow and slight post-indentation, each bearing two finned, long, antapical spines on its postero-lateral corner, which expand posteriorly. The antapicals are deeply indented by the ventral area, and also by the dorsal postcingular plate C.

The surface is smooth. The intercalary bands are broad and striated.

The girdle plane being perpendicular to the major axis, the long spreading antapical spines, the distinct apical horn distinguish it from *P. pallidum* OSTENFELD. This species is distinguished from *P. michaelis*, by its spreading spines, swollen epitheca, different type and number of

thecal plates and by having no proximal arch of the girdle.

Dimensions: Length, $59-75\mu$; transdiameter, $38-50\mu$; dorso-ventral diameter, $34-40\mu$.

Loc. Off Futagojima, Aug. 23, 1926.

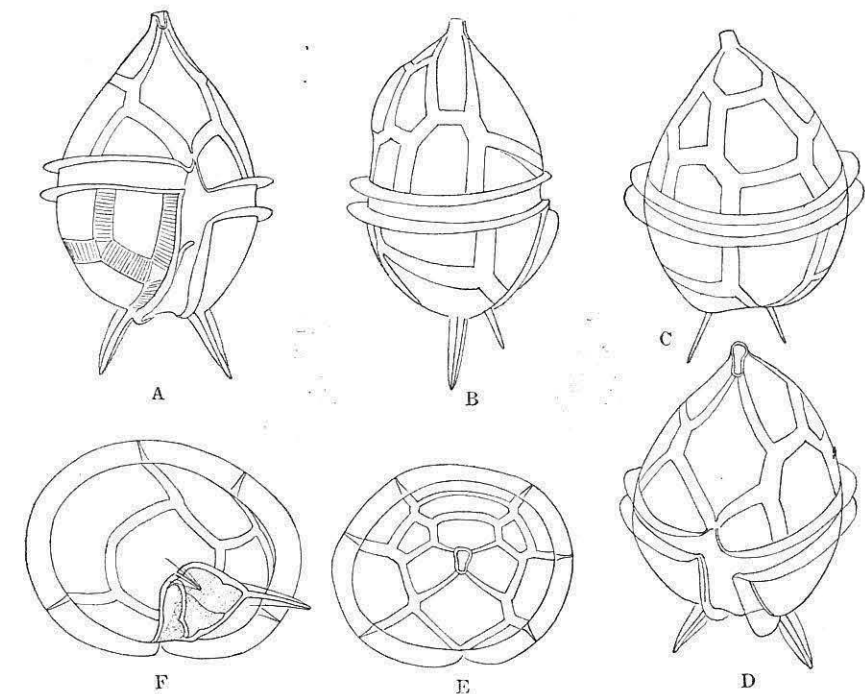


Fig. 20. *Peridinium okamurai*, n. sp.

A, Ventral view. B, Side view. C, Oblique dorsal view. D, Antero-ventral view. E and F, Apical and antapical (oblique) view. ($\times 600$)

18) *Peridinium oceanicum* VANH. v. *oblongum* AURIV.

AURIVILLIUS 1898, p. 96.

SCHÜTT 1895, Pl. VIII, Fig. 44 (?).

PAULSEN 1908 p. 55, Fig. 70.

BROCH 1910, p. 190, Fig. 7.

FORTI 1922, p. 90, Pl. VI, Fig. 83.

A spheroidal species with long or short apical and antapical horns and a flat list along the right ridge of the longitudinal furrow.

Dimensions: Length, 90–120 μ ; transdiameter, 60–65 μ ; dorso-ventral transdiameter, 50 μ .

Loc. Off Asamusni, Aug. 21, 1926.

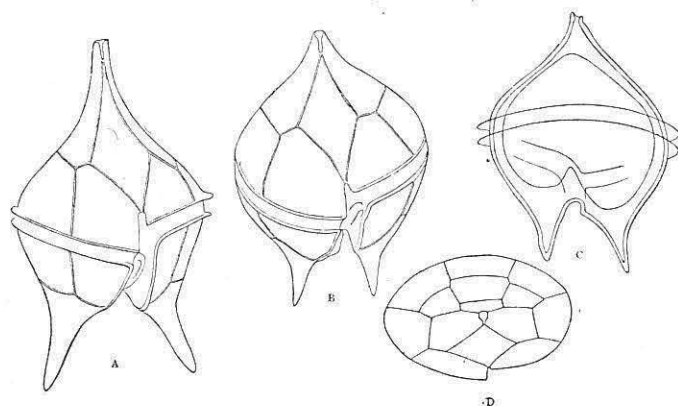


Fig. 21. *Peridinium oceanicum* VANH. v. *oblongum* AURIV.

A, Somewhat elongated specimen. B and C, Rotund specimens. D, Arrangement of the plates on the epitheca. ($\times 280$)

19) *Peridinium adriaticum* BROCH.

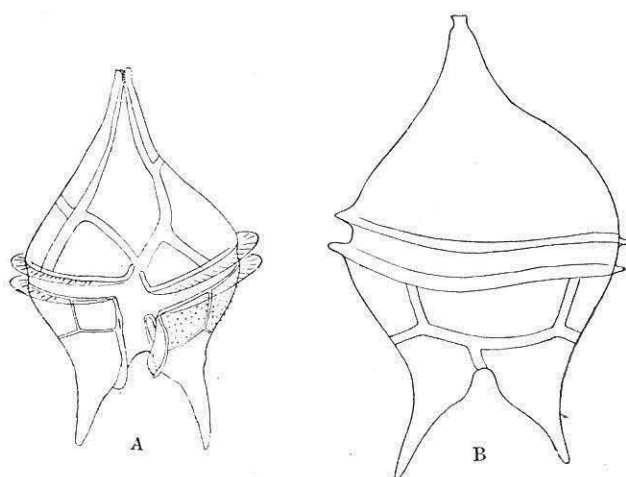


Fig. 22. *Peridinium adriaticum* BROCH.

A, Ventral view. B, Dorsal view of another specimen. ($\times 600$)

BROCH 1910, p. 191, Fig. 8.

FORTI 1922, p. 91, Pl. VII, Fig. 84.

This species is akin to *P. oceanicum* except that its ascending girdle is displaced distally one girdle's width. The plates are of the *Metaperidinium* type. The surface is reticulated with small thorns in their nodes. The longitudinal furrow is guarded laterally with a well developed left and a flat right fin.

Dimensions: Length, 75–81 μ ; transdiameter, 47–51 μ .

Loc. Off Asamushi, Aug. 15, 1926.

20) *Peridinium koma*, n. sp.

A small, trochoidal species with a broad ventral area and an asymmetrical antapical horn.

The body is broad peg-top form with an eccentric antapical horn. The epitheca is conical, of which the anterior sides gradually merge into the apical horn. The plates in the epitheca are of the *Orthoperidinium* type with three intercalaries. The apical *r* is a slender plate and the other *2*, *3*, and *4* are relatively small. In the intercalaries dorsal *d* is larger than the rest. The apical *a* and *g* are elongated plates, but the plates *b*, *f*, and *c*, *e* diminish their altitudes in order, the dorsal *d* is the shortest in its altitude. The girdle is narrow and post-median. The furrow is not deeply impressed, descending with the distal arch, and is displaced distally its own width. The ventral area is very broad and subterminal. The hypotheca is subhemispherical, bearing a prominent antapical horn a little to the right of the median axis. There is a slight elevation on the left side of the post-margin suggestive of a left rudimentary antapical horn.

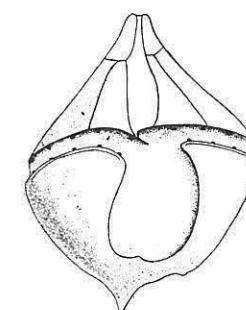


Fig. 23. *Peridinium koma*, n. sp. ($\times 600$)

No corresponding species has been reported as far as I know, except *Heterocapsa pacifica* which has some resemblances in having the asymmetrical horn and the slight rudimentary elevation, though on the opposite side.

Dimensions: Length, 57 μ ; transdiameter, 47 μ .

Loc. Off Asamushi, Aug. 15, 1926.

21) *Peridinium conicum* (GRAN).

*OSTENFELD u. SCHMIDT 1900, p. 174.

OKAMURA 1907, p. 132, Pl. V, Fig. 33.

PAULSEN 1908, p. 58, Fig. 74.

BROCH 1910, p. 195, Fig. 11.

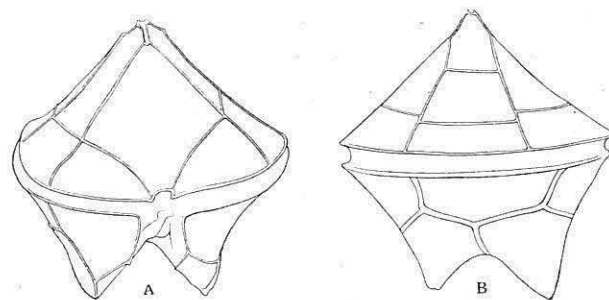
FORTI 1922, p. 88, Pl. VI, Fig. 79.

P. divergens pyramidale KARSTEN 1907, Pl. XXIII, Fig. 14.

A short and broad species with distinct, conical, antapical horns. The epitheca is broadly conical, with slightly concave or nearly straight sides. The cross section at the girdle is reniform. The antapical horns are formed by the deep post-indentation of the posterior part of the ventral area, and are somewhat laterally compressed. Judging from many observations, there is a tendency that the precingular-apical intercalary bands in the ventral and the precingular-intercalary intercalary bands in the dorsal area to be less developed than the others, so that only these bands between two adjacent plates in one and the same series and also the apical-intercalary intercalary bands are distinctly detected.

Dimensions: Length, 95μ ; transdiameter, 90μ .

Loc. Asamushi, Aug. 15, 1926.

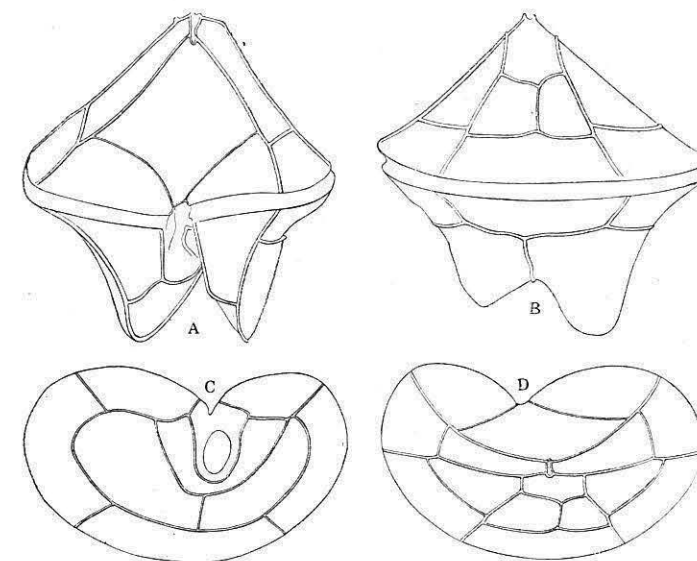
Fig. 24. *Peridinium conicum* (GRAN).A, Ventral view. B, Dorsal view. ($\times 280$)22) *Peridinium conicum* (GRAN) forma *asamushi*, n. form.

This differs from the preceding species in having two dorsal intercalary plates. The dorsal intercalary plate δ is divided by a

longitudinal band into two unequal plates, the larger left and the smaller right.

Dimensions: Length, 105μ ; transdiameter, 107μ .

Loc. Off Asamushi, Aug. 13, 1926.

Fig. 25. *Peridinium conicum* (GRAN) forma *asamushi*, n. form.A, Ventral view. B, Dorsal view. C and D, Arrangement of the plates on the hypotheca and the epitheca. ($\times 280$)23) *Peridinium crassipes* KOFOID.

KOFOID 1907(e), p. 309, Pl. XXXI, Figs. 46, 47.

PAULSEN 1908, p. 58, Fig. 73.

BROCH 1910, p. 193, Figs. 9, 10.

MANGIN 1910, Pl. VIII, Figs. 1-5.

FORTI 1922, p. 92, Pl. VII, Fig. 86.

A medium-sized, broad species with blunt short antapical horns, and the proximal arch of the girdle. The cross section at the girdle is broad reniform, not so dorso-ventrally flattened. Two or three small protuberances are observed in the ventral view on the top of the semi-truncated end of the antapical horn, the outermost of them is the longest and corresponds to the real tip of the horn. The one or

two inner processes are not the real spines, but of the posterior extensions of the lists of the longitudinal furrow and that along the rim of the longitudinal intercalary bands. The antapical horn is not dorso-ventrally thickened, but on the contrary flattened without forming dorsal and ventral angles, as the San Diego specimens. The slight concavity of the sides of the epitheca shows an intermediate form between form *typica* and form *autumnalis*.

Dimensions: Length, 87μ ; transdiameter, 93μ .

Loc. Off Hadakaiwa, Aug. 8 and 29, 1926.

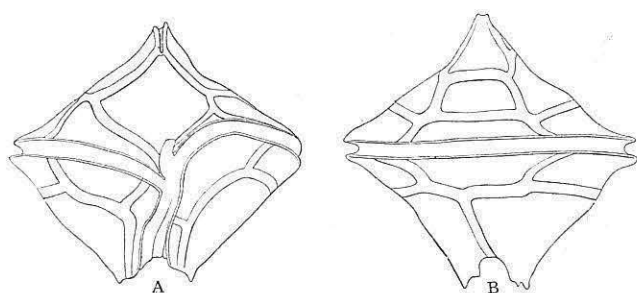


Fig. 26. *Peridinium crassipes* KOFOID.

A, Ventral view. B, Dorsal view. ($\times 280$).

24) *Peridinium crassipes* KOFOID forma (?).

This form differs from the preceding in having a different plate arrangement, less pronounced proximal arch, and distal displacement

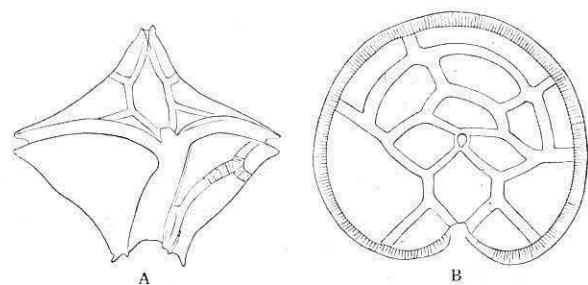


Fig. 27. *Peridinium crassipes* KOFOID forma (?).

A, Ventral view. B, Apical view. ($\times 280$).

of the girdle and more concave epithecal wall. The plates of the epitheca are of the *Paraperidinium* type with distinctly displaced dorsal plates to the left.

Dimensions: Length, 78μ ; transdiameter, 81μ .

Loc. Off Hadakaiwa, Aug. 8, 1926.

25) *Peridinium pentagonum* GRAN.

*GRAN 1902, p. 185. 190.

PAULSEN 1908, p. 59, Fig. 77.

CONRAD 1926, p. 96, Pl. II. Figs. 41, 42.

P. divergens pentagonum KARSTEN 1907, Pl. XXIII. Fig. 11.

Dimensions: Length, 64μ ; transdiameter, 75μ .

Loc. Off Hadakaiwa.



Fig. 28. *Peridinium pentagonum* GRAN. ($\times 280$).

26) *Peridinium pentagonum* GRAN forma *depressum*, n. form.

A broad and flattened form of *P. pentagonum*. The girdle is nearly circular, not showing the strong proximal arch and distal displacement. Body is strongly flattened dorsoventrally, so that the cross-section at the girdle is a flat reniform, which makes the body very transparent and hyalinous. The intercalary bands in this form are irregularly developed. The same relations as already pointed out in *P. conicum* are also noticed in this form in a more pronounced degree, so that in the apical view only three lateral suture lines with two short dorso-ventrally connecting bands near the apex are seen with distinctness while others are not worked out even with close examination, except one or two suture lines which are only surmised through the somewhat lineally arranged ridges of the fine polygonal meshes on the reticulated surface. It seems an extreme case of the irregular development of the band seen in *P. conicum*. In the hypotheca only one lateral line is prominent, probably these between A-B and D-E. This type of

irregularity is wholly different from that described by BROCH in *P. conicum*.

Dimensions: Length, 72μ ; transdiameter, 87μ ; dorso-ventral diameter, 35μ .

Loc. Asamushi, Aug. 20, 1926.

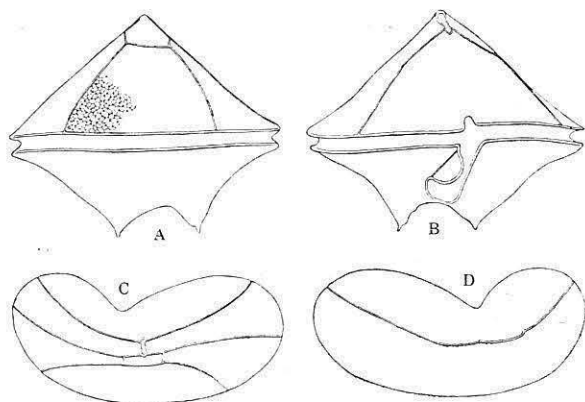


Fig. 29. *Peridinium pentagonum* GRAN forma *depressum*, n. form.

A, Dorsal view. B, Ventral view. C and D, Suture lines of the epitheca and the hypotheca. ($\times 280$)

27) *Peridinium quinquecorne*, n. sp.

A small, peculiar species with four antapical spines on the post-margin.

Body is rotund posteriorly and pointed anteriorly. Its length is 1.3 transdiameter.

The epitheca is subconical with an indistinct short apical horn. The apical pore has a short ventral slit with a small finger-like protuberance projecting on its dorsal wall. The plate formula of the epitheca is 4^l , 2^v , and 7^a . The ventral precingular plates a and g are the largest while the two dorso-lateral intercalaries are the smallest. The lateral apical 2 and 4 are somewhat concave, forming the side walls of the apical horn. The dorsal apical 3 is a somewhat large septagonal and is directly adjacent to the small precingular d . The girdle is comparatively wide and is deeply impressed with distinct side lists of the body wall. It is quite post-median, so that the

epitheca exceeds the hypotheca, excluding the spines, the ratio of the altitudes of epitheca to hypotheca being 0.53. The furrow is slightly descending, and is displaced distally its half width without a marked proximal arch. The section at the girdle is flattened reniform. The hypotheca is somewhat polygonal in ventral view, four spines on each angle. The postcingular plates are low in altitude while the major part of the hypotheca is covered with two antapicals, the spines being on the latter.

The central right spine is displaced dorsally while the rests are middle or slightly ventral, but the central left is the longest of the four though not so distinct as in *Gonyaulax triacantha*. The spines, except the right-most one, are slightly curved inwardly or ventrally. The ventral area is broad and subterminal resembling much that of *G. triacantha*. The surface is smooth without any markings.

Gonyaulax triacantha is the sole species which has a close resemblance to this species in having many antapical spines and a flattened girdle section. The first glimpse of this specimen made me conjecture that it belongs to *G. triacantha*, but close examination of the general shape, the arrangement of the plates, the structure of the girdle, and the ratio of the epitheca to the hypotheca have proved it to belong to a wholly different genus *Peridinium*. No corresponding form was found in the genus.

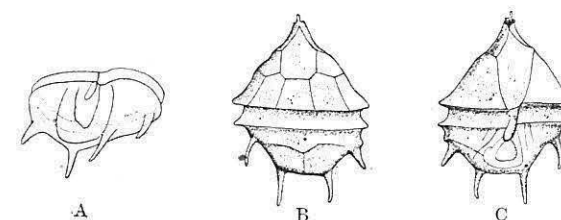


Fig. 30. *Peridinium quinquecorne*, n. sp.

A, Ventral polar view of the hypotheca of an incomplete specimen. B, Dorsal view of another specimen. C, Ventral view. ($\times 600$)

Fuller accounts will be given when I could get enough material to further analyse their structures as I have here observed only two individuals, one incomplete and one complete one.

Dimensions: Length, 30μ (excluding antapical spines); transdiameter, 26μ .

Loc. Off Hadakaiwa, Aug. 11, 1926.

28) *Peridinium achromaticum* LEVAND.

*LEVANDER 1902, 49, Figs. 1, 2.

OSTENFELD 1908, p. 165, Pl. V. Figs. 29-30, 40-43.

PAULSEN 1908, p. 62, Fig. 80.

A small species with a broad girdle, rounded hypotheca and bluntly pointed epitheca. The epitheca is subconical, bearing a long ventral slit of the apical pore at the apex. The section at the girdle is approximately circular. The hypotheca is rounded without ventral flattening, but the ventral area is deeply excavated which widening and deepening posteriorly extends to the post-margin.

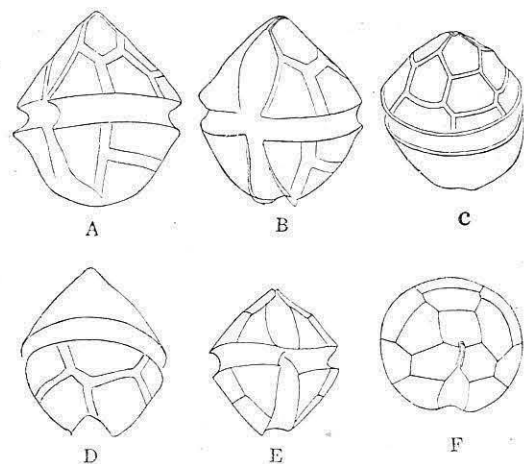


Fig. 31. *Peridinium achromaticum* LEV.

A and B, Left ventral view. C, Left dorsal view of another specimen. D, Dorsal antapical view showing the asymmetrical dorsal postcingular C and the displaced intra-antapical suture. E, Ventral view of a different specimen. F, Epithecal view of the pattern of the plates in the C specimen. ($\times 600$)

The furrow is guarded by a low fin on each side, which broadens posteriorly. A minute spine-like process is seen in the ventral view on each side of the furrow at the antapex which is not a spine but

the image of the posterior extension of the side fin formed in its lengthwise view. The surface is smooth, except the broad intercalary bands in which faint transverse striations are observed.

Its epithecal plates are 14 in number having three intercalaries, which agrees with the LEVANDER's Finland specimens.

Dimensions: Length, $28-38\mu$; transdiameter, $24-31\mu$.

Loc. Off Futagojima, Aug. 23, 1926.

29) *Peridinium levanderi*, n. sp.

A small, broad rhombic species with a wide girdle. The body is a rounded square in ventral view with somewhat pointed apical and broad antapical ends. Its length is slightly longer than the width, being 1.1 transdiameter. The epitheca is broad conical with slightly convex sides. The apical pore is small with a long ventral slit. The apical τ is an elongated plate, and the small hexagonal z and ϕ make the apex triangular in cross-section with the quadrangular dorsal apical β . The intercalaries γ and ε are of unequal size in the middle in the dorsal surface in saddle-fashion, comprising the larger left and the smaller right to the reversal result of the size of the precingulars c and e . The ventral precingulars a and g are tall, trapezoidal plates, measuring about 0.76 altitudes of the epivalva. The plates b and f have nearly the same altitude but are much broader, and the dorsal d is a small, flat, pentagonal plate. The girdle is broad, slightly descending, and is displaced distally one-third of its width. The furrow is deeply impressed with low side lists. The hypotheca is somewhat dorso-ventrally flattened posteriorly, and the post-margin of the ventral area is indented slightly, leaving the lateral part of it in two blunt antapical horn-like processes. The ventral area is narrow without marked posterior widenings. The surface is smooth and the plasm is colourless. The intercalary bands are narrow.

I am in doubt whether this species is the one just corresponding to *P. achromaticum* L. LEVANDER reported 14 plates in the epitheca in the Finland specimens, while OSTENFELD found and figured only 13 plates in the Aral specimens of *P. achromaticum*, which has two separated intercalary plates. Our specimens correspond to the latter in having 13 plates in the epitheca, but differ from it in the relative

size of the plates and the arrangement of the intercalaries. In the Aral and the Finland specimens, the apical plates 2, 3, and 4 are comparatively larger and the intercalaries smaller as compared with our Mutsu specimens, so that the anterior ends of the precingular plates *a* and *g* of the former are far behind the corresponding lines of our specimens in ventral view. The ventral area is narrow in the Aral and broad in the Finland specimens (according to PAULSEN's figure), while in ours both types are detected.

No antapical spines, reported both from the Aral and the Finland specimens, were observed in our specimens. Notwithstanding these differences, there is no doubt of the existence of a close similarity or relation between the two.

Dimensions: Length, 37μ ; transdiameter, 34μ ; dorso-ventral diameter, 32μ .

Loc. Off Futagojima, Aug. 23, 1926.

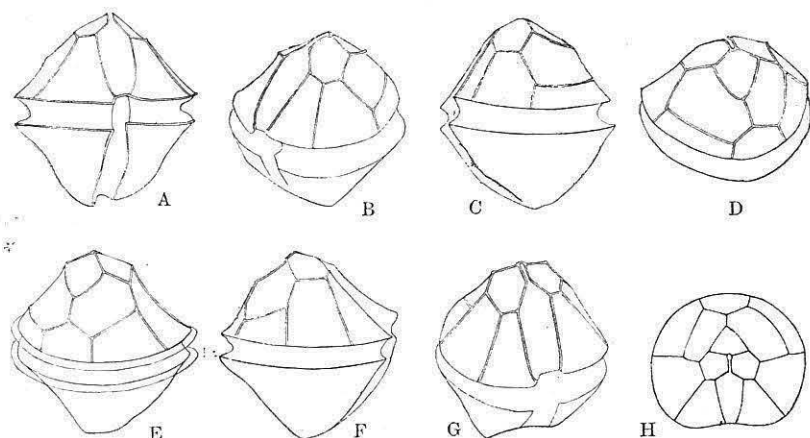


Fig. 32. *Peridinium levanderi*, n. sp.

A, Ventral view. B, Left ventral view. C, Left side view. D, Left dorsal view. E, Right dorsal view. F, Right side view. G, Right ventral view. H, Arrangement of the plates in the epitheca. ($\times 600$)

30) *Peridinium munobis*, n. sp.

A small, *achromaticum*-like species with a pre-median girdle. The epitheca exceeds the hypotheca.

The epitheca is flat and conical, with somewhat convex sides and a pointed apex. The apical pore bears a short, narrow ventral slit (but not having any real opening). The plates are of the *Orthoperidinium* type with three dorsal intercalaries. The girdle is relatively wide and circular, bearing the side ridges of the thecal wall. The furrow is deeply impressed with numerous transverse striations on its wall. The ventral area is wide, guarded by very low side fins increasing its width posteriorly, of which the posterior parts will be easily misinterpreted as minute antapical spines in a ventral view. The hypotheca is rounded posteriorly, with a swollen, distinctly convex, ventral side; its posterior end is flattened dorso-ventrally. The ventral area is wider than the girdle of which the posterior end is slightly indented.

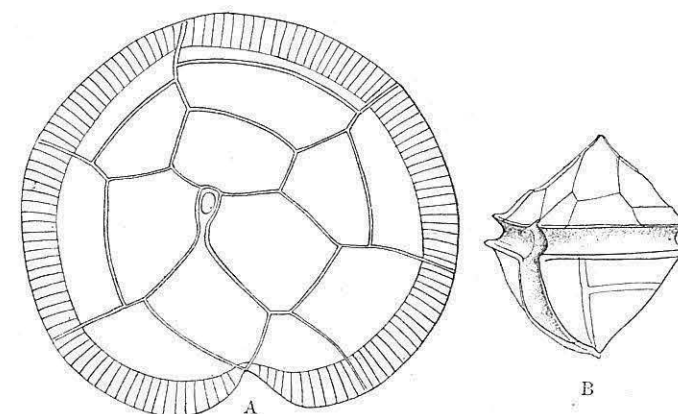


Fig. 33. *Peridinium munobis*, n. sp.

A, Apical view. ($\times 1500$) B, Left side view. ($\times 600$)

In inspecting plankton this species is apt to be easily confused with *P. achromaticum* and *P. levanderi* because of their minute size and broad, rhombic shape. This species is distinguished at once from them by its anteriorly displaced girdle plane. *P. achromaticum* is easily distinguished from *P. levanderi* by its larger size, relatively pointed antapical end and somewhat wider ventral area. In the three, the precingular series of plates of this species are the least developed in contrast to the well developed apical plates.

Dimensions: Length, 44μ ; transdiameter, 39μ .
 Loc. Off Futagojima, Aug. 23, 1926.

31) *Peridinium biconicum*, n. sp.

A medium-sized, somewhat elongated, rhombic species with a hyaline antapical fin and a descending girdle.

The body is biconical antero-posteriorly with straight or slightly concave sides. The epitheca is conical with a slit-like apical pore at its pointed apex. The pore has long ventral and dorsal slits, resulting in an elongated aperture with a somewhat wider part, the apical pore, near its dorsal end. The lateral walls of the pore project in short finger-like processes at the anterior ends of the intercalary bands between the apical plates 2-3, and 3-4. In some specimens a flat, hyalious, membrane-like structure is seen along the whole length of the aperture, but it probably is a process of the inner plasm through the pore. The plate formula is $4'$, 2γ , 7^a and 5^d , 2^l . The apical r is a long, narrow plate of which the surface is slightly concave, and the dorsal rhombic 3 is smaller than the lateral ones. The ventral precingulars a and g are the largest and the dorsal pentagonal d is the smallest in the series. The large hexagonal intercalaries γ and ε are in the middle of the dorsal surface bilaterally, in saddle fashion. The intercalary bands are broad and well developed, with transverse striations.

The girdle is median, slightly descending, and is displaced distally 1.5 girdle width. The furrow is deeply impressed with side lists and numerous transverse parallel ribs and grooves on its wall. The ventral area is narrow but is deeply impressed, without posterior widening and with low lateral fins. The ventral area extends to the post-margin, diminishing in depth, with a deep subterminal, asymmetrical excavation on the ventral left side, so that at the hindermost part of the body, the left half of the ventral part is impressed, making the remaining part somewhat obliquely semi-circular in cross section, while the post-margin forms a small shovel-like fin. In some specimens a spine-like thickening is seen medially. The ventral side of the hypotheca is strongly convex, and along its median line is the deeply excavated ventral area. The surface is smooth without any markings.

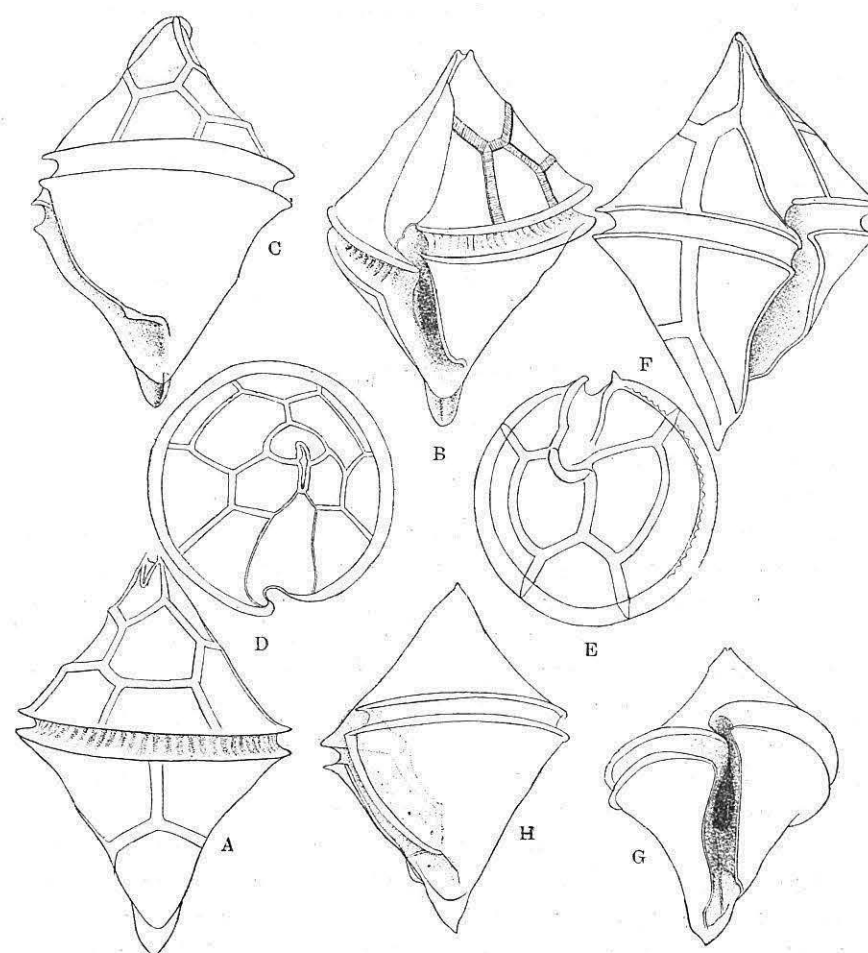


Fig. 34. *Peridinium biconicum*, n. sp.

A, Dorso-lateral view. B, Ventral view. C, Left side view. D and E, Arrangement of the plates on the epitheca and the hypotheca. F, Right ventral view of another specimen. G, Antapical ventral view of the hypotheca, showing the ventral area of a smaller specimen. H, Left side view of G specimen showing the depression of the ventral area, the flagellar pore, and the side fins of the furrow. ($\times 600$)

Murrayella punctata (CLEVE), *Heterocapsa triquetra* STEIN, and *Ceratium biconicum* MURR. and WHITT. are closely resembling species. *Murrayella punctata* differs from this species in having distinct surface markings, a rounded anterior end, short, oblique, ventral area and no

antapical fin. This also differs from *Heterocapsa triquetra* in size and in having a more pointed apical end, a narrower girdle, a less developed antapical horn, no ventral epithecal furrow, and a straight but long posterior-ventral furrow. From *Ceratium biconicum* it differs profoundly in its broader body, pointed anterior end and faintly listed, deep, ventral furrow.

Dimensions: Length, 70μ ; transdiameter, 47μ ; dorso-ventral dimension, 44μ .

Loc. Off Futagojima, Aug. 20, 1926.

32) *Peridinium ventricum*, n. sp.

A small, asymmetrically biconical species. The hypotheca markedly exceeds the epitheca.

The epitheca is a flat subcone, bluntly pointed anteriorly, with a slight ventral concavity. The apical pore is not on the anterior extremity but is distinctly displaced ventrally, lying in the node of the apical plates 1, 2, and 4, bearing a peculiarly long dorsal slit (truly only a groove) instead of a ventral one, passing over the anterior end, extending to the middle of the dorsal apical plate 3. The apical pore is in the ventralmost end of the slit. The plates are of the *Orthoperidinium* type with two unequal intercalaries. The dorsal apical plate 3, the intercalaries, and the precingular plate 4 are displaced somewhat to the right side of the body and all of them are more or less irregularly shaped. The section at the girdle is semicircular with a slight ventral excavation. The girdle is relatively wide, deeply impressed, descending, and is displaced distally one girdle width, with side-ridges of the thecal wall. The ventral area is narrow and deeply impressed, extending to the antapex where it widens slightly. The hypotheca is a somewhat elongated subcone with concave dorsal and somewhat convex ventral sides, and narrow but faint post-indentation, bearing or not bearing a low fin along its right post-margin. The postcingulars are one-third of the antapicals in their altitude except the ventral A and E which occupy its entire length. The surface is smooth and the intercalary bands are very narrow.

From *P. biconicum*, which this species resembles most closely, it is distinguished at once by its smaller size and anteriorly displaced girdle

plane. This dorsal elongation of the apical slit-like groove is also fairly developed in *P. biconicum* in which the pore lies a little ventrally from its dorsal end. This ventral displacement of the apical pore or the dorsal elongation of the slit of this biconical species serves to separate it from all other species in the genus.

Dimensions: Length, $51-54\mu$; transdiameter, $42-47\mu$.

Loc. Off Futagojima, Aug. 23, 1926.

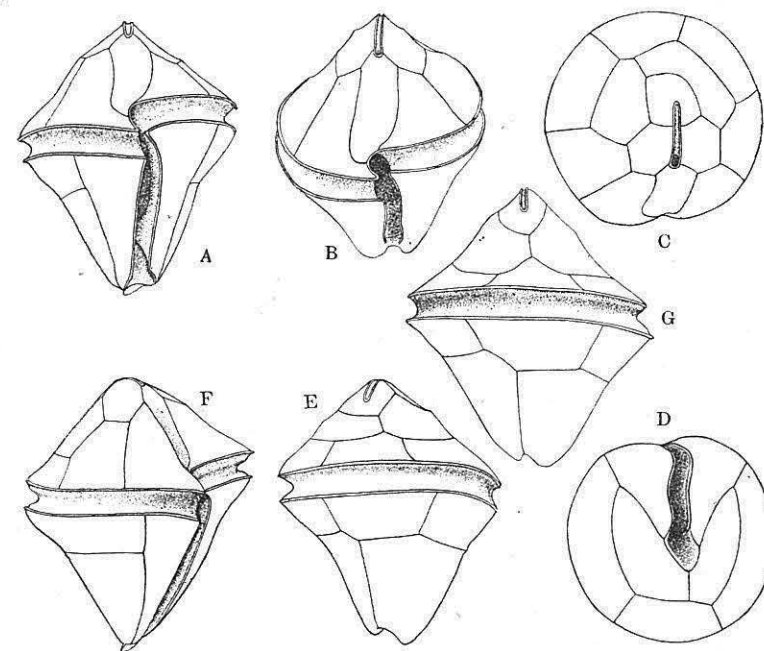


Fig. 35. *Peridinium ventricum*, n. sp.

A, Ventral view. B, Antero-ventral view. C and D, Apical and antapical view. E, Right dorsal view. F, Right side view. G, Dorsal view of another specimen. ($\times 600$)

CONGRUENTIDIUM, n. gen.

The body is of nearly bilateral symmetry. In ventral view its form resembles some *Peridinium* in the presence of a small apical horn and widely separated antapical spines. The body is strongly dorso-ventrally flattened, with a dorsally inclined girdle plane. The

epitheca is subequal to the hypotheca, its peripheral part is thin, forming a meridional edge. The plates are as follow: four apicals, one apical intercalary, five precingulars, five girdle plates, five postcingulars, one antapical intercalary, and two antapicals. In the smaller number of the precingular plates and in the development of the intercalary plate in the rear of the ventral area, coupled with the dorso-ventral flattening, it differs from *Peridinium*. By the different number and the symmetrical arrangement of the plates, and by the presence of the nearly completing girdle, it is distinguished from *Heterodinium*.

33) *Congruentidium compressum*, n. sp.

A peculiarly flattened, pentagonal species with a minute apical horn and two small, widely separated antapical spines intervening a shallow but wide post-indentation.

The body is pentagonal, strongly flattened dorso-ventrally, its length is 1.03 transdiameter and its dorso-ventral diameter on the middle of the girdle level is 0.26 transdiameter. The cross-sections at the girdle and in the dorso-ventral meridional plane are both elongated and are somewhat slightly deformed spindle shapes. The epitheca is not so strongly flattened as the hypotheca, as the post-marginal part of the latter is extremely thin. The epitheca is broad and slender conical in ventral and side views, respectively, provided with convex sides and a slight step-like shoulder in the apical-precingular suture. Its sides contract to a small but distinct apical horn, widening slightly anteriorly, with a minute pore and a narrow ventral slit which continues to a fine canal leading into the inner cavity. The thecal wall is thick, especially in the marginal parts where the dorsal and the ventral walls fuse to form a broad and very thick wall except at the apex where a fine canal connects the narrowed cavity with the pore penetrating through the wall. The plate structure is obscured by the inner plasma at the central part, so that it is very difficult to analyse fully the relations of the plates in the central region. The plates comprising the epitheca are 10 in number. The mid-ventral apical 1 is an elongated, rhombic plate narrowing anteriorly, and the other apicals are all triangular, two small ones, 2 and 4, on the lateral sides of the former and a large one, 3, on the dorsal, occupying nearly its anterior

half with an incurved basal rim. The precingular plates are all low in altitude, numbering 5, comprising two ventral, two side, and one flat dorsal plate. Along the middle of the side precingular plates are the marginal body edges. A flat, somewhat lens-shaped intercalary plate is on the dorsal side, two ends of which are truncated obliquely. The girdle is relatively wide, ascending slightly, and is displaced distally. It is median in the ventral and distinctly post-median in the dorsal, so that the girdle plane inclines dorsally about 60°. The furrow is deeply impressed with low but stout sidelists. The ventral area is narrow and short, only extending posteriorly half way between the girdle and the post-margin. It expands a little abruptly to the right to form a pocket-like depression in the bottom of which lies the flagellar pore, but in some specimens this impression is seen along the middle of the area instead of on its right side. The anterior plate indents the hypotheca a little, ending in a sharply truncated terminal. The hypotheca is broad and trapezoidal with two spines on the widely separated angles and also shoulders in the postcingular-antapical sutures. The post-margin is slightly indented, the bottom of which is nearly straight, and slightly convex or concave at the intra-antapical suture. The antapical horn is short, and is hardly appreciable in some specimens, ending in a small spine. Low hyaline, denticulated fins are seen in some of them, along the sides and the posterior margins of the antapical plates. The postcingular-antapical suture is broad, subparallel to the girdle in the dorsal, but strongly displaced posteriorly in the ventral side by the development of the large ventral intercalary plate. The postcingular plates are 5 comprising one dorsal, two lateral, and two ventral ones. The antapical are two, each covering the postero-lateral corners. A large intercalary plate is at the rear of the ventral area, indenting the antapicals deeply. It is also slightly concave following the ventral area. The intercalary bands between different series of plates are broad and striated, but those of the intraserials are narrow, except the intra-antapical one. The surface is smooth.

This peculiar and interesting species has, as far as I know, clearly defined and isolated characters which distinguish it from any other species of all the *Peridiniales*. It is remarkable in form, in the strong dorso-ventral flattening and in the dorsal inclination of the girdle plane, as well as in the number and the arrangement of the thecal plates.

In the characters of the widely separated antapical spines, it is closely related to *Gonyaulax catenata*, but differs in having the small antapical horn, smaller number of the antapical spines, the epithecal and the hypothecal shoulders, and the strong flattening. From some strongly flattened species of *Heterodinium*, it is distinguished by its plate arrangement and the dorsally inclined girdle plane, as well as in having a complete girdle furrow and two antapical plates.

Dimensions: Length, 62–65 μ ; transdiameter, 58–63 μ ; dorso-ventral dimension, 15 μ .

Loc. Off Futagojima, Aug. 23, 1926.

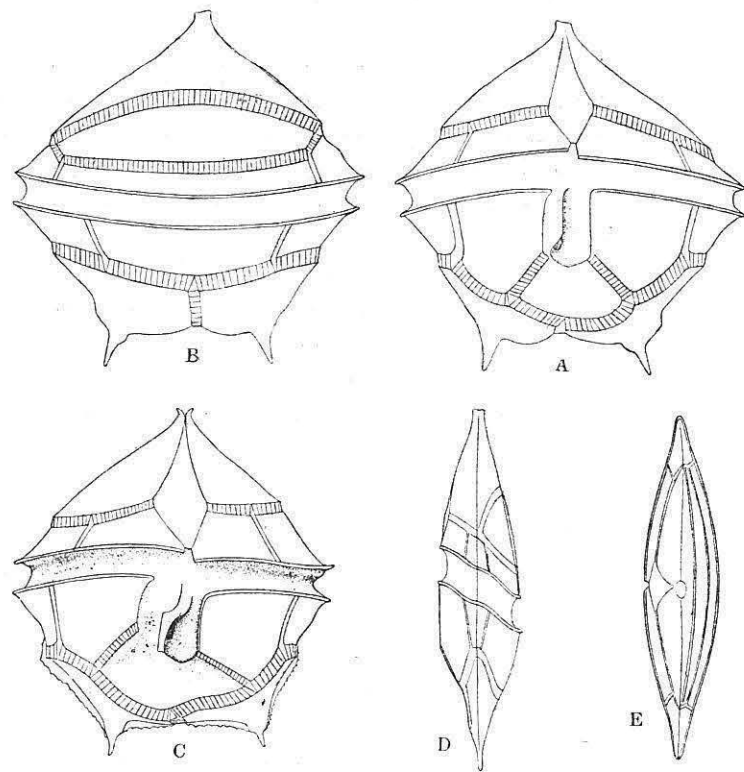


Fig. 36. *Congruentidium compressum*, n. g., n. sp.

A, Ventral view. B, Dorsal view. C, Ventral view of another specimen. D, Side view. E, Diagram of the pattern of the plate in the epitheca. ($\times 600$)

CERATIUM SCHRANK.

34) *Ceratium furca* subsp. *eugrammum* (EHRBG).

JØRGENSEN 1911, Pl. II, Figs. 24, 25, 26.
* *Peridinium eugrammum* EHRENBURG 1859, p. 792.

Dimensions: Length, 135 μ ; transdiameter, 17 μ .

Loc. Off Asamushi, Aug. 16, 1926.

35) *Ceratium fusus* (EHRBG).

* EHRENBURG 1853, p. 271, 1834,
Pl. II, Fig. 3.
PAULSEN 1908, p. 91, Fig. 123.
OKAMURA & NISHIKAWA, 1904,
p. 127, Figs. 22, 23.
SCHÜTT 1895, Pl. IX, Fig. 35.

The right antapical horn is short and rounded.

Dimensions: Length 400 μ ; transdiameter, 24 μ .

Loc. Off Asamushi, Aug. 10, 1926.

Fig. 37. *Ceratium furca* subsp. *eugrammum* (EHRBG). ($\times 600$)

36) *Ceratium pulchellum* SHRÖDER.

SCHRÖDER 1900, Pl. I, Fig. 17e.
JØRGENSEN 1911, p. 23, Pl. III, Figs. 59, 60, 61.

Dimensions: Length, 400 μ ; transdiameter, 85 μ .

Loc. Off Asamushi, Aug. 20, 1926.

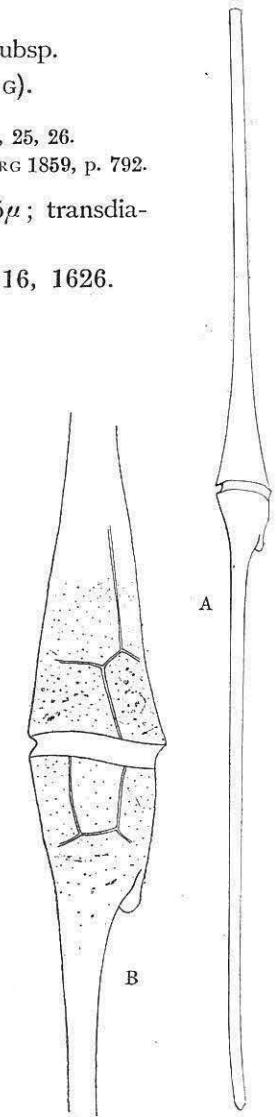


Fig. 38. *Ceratium fusus* (EHRBG).
A, Straight specimen. ($\times 280$)
B, Mid-body. ($\times 600$)

37) *Ceratium pulchellum* var.
longipes, n. var.

The shallow post-indentation and widely spreading antapical horns serve to distinguish this variety from the former species.

Dimensions: Length, 430μ ; transdiameter, 81μ .

Loc. Off Asamushi, Aug. 23, 1926.

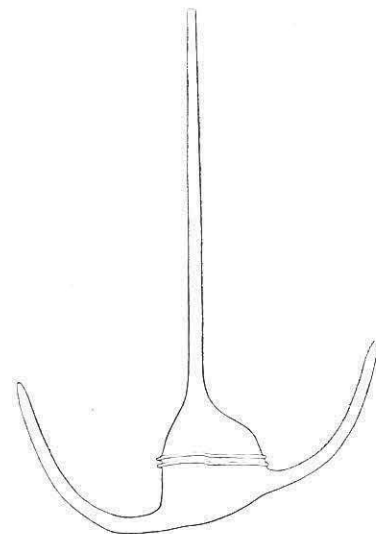


Fig. 39. *Ceratium pulchellum*
SCHRÖD. ($\times 280$)

38) *Ceratium tripos*
(O. F. MÜLLER) var.
atlantica OSTFELD.

*OSTENFELD 1903, p. 584, Figs. 132, 133.

PAULSEN 1908, p. 77, Fig. 120.

JØRGENSEN 1911, p. 36, Pl. IV, Figs. 69–73.

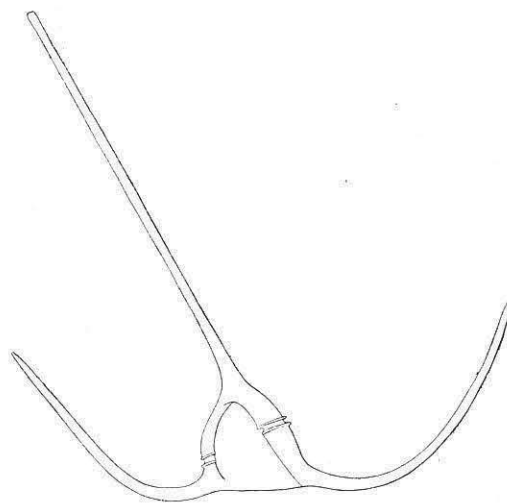


Fig. 40. *Ceratium pulchellum* var. *longipes*, n. var. ($\times 280$)

Dimensions: Length, $260-300\mu$; transdiameter, $73-78\mu$.
Loc. Off Asamushi Aug. 8, 1926.

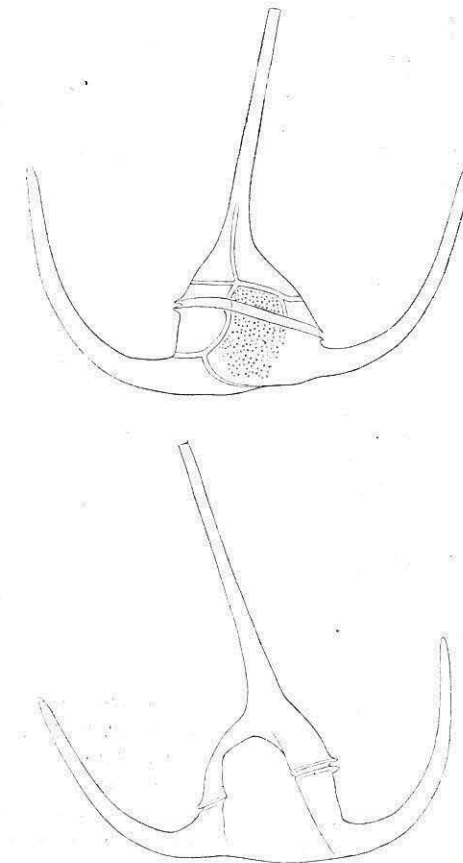


Fig. 41. *Ceratium tripos* var. *atlantica* OSTFELD. ($\times 285$)

39) *Ceratium tripos* var. *subsalsum* OSTFELD.

*OSTENFELD 1903, p. 584, Fig. 134.

PAULSEN 1908, p. 79, Fig. 104.

BORGERT 1919, Pl. I.

JØRGENSEN 1911, p. 36, Pl. III, Figs. 66, 67.

Common species in summer.

Dimensions: Length, $94-153\mu$; transdiameter, $41-49\mu$.

Loc. Off Asamushi, Aug.
20, 1926.

40) *Ceratium bucephalum*
var. *heterocamptum*

JØRGENSEN.

C. bucephalum var. *heterocamptum*
JØRG. 1899, p. 44, Pl. II, Fig. 12.

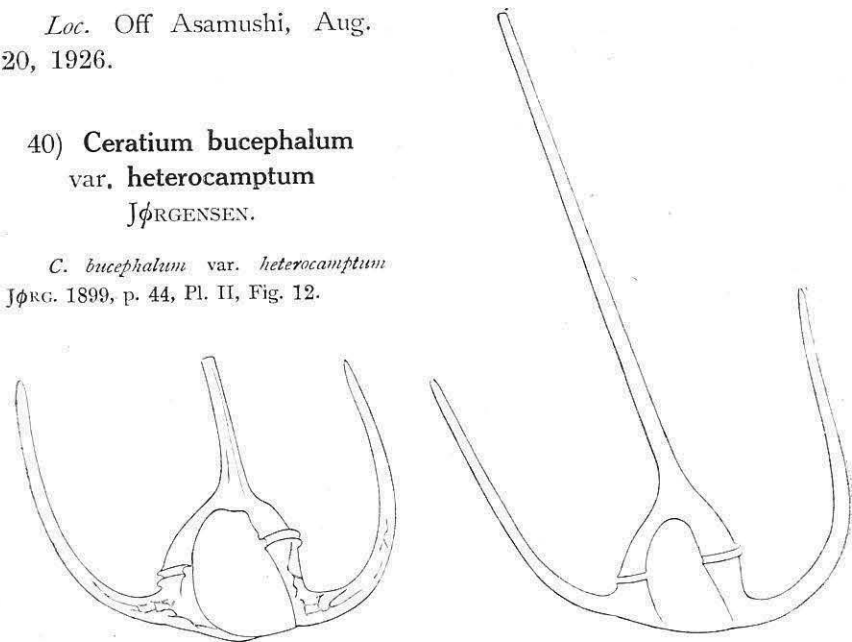


Fig. 42. *Ceratium tripos* var. *subsalsum* OSTFELD. ($\times 280$)

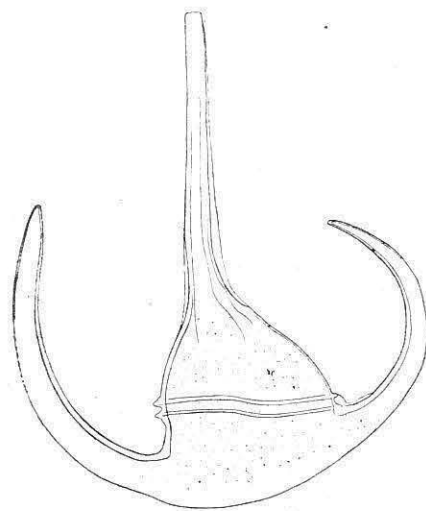


Fig. 43. *Ceratium bucephalum* var.
heterocamptum JØRG. ($\times 280$)

C. (tripos var.) *arietinum* CLEVE 1900
(a), p. 13, Pl. VII, Fig. 3.

C. heterocamptum, PAULSEN 1908, p.
76, Fig. 101.

C. buceph. var. *heterocamp.* JØRGENSEN
1911, p. 48, Pl. V, Fig. 101.

The distal part of the right
antapical horn shows a charac-
teristic curve, distinctly turning
inward nearly perpendicular to
the apical horn.

Dimensions: Length, 162μ ;
transdiameter, 56μ .

Loc. Off Asamushi, Aug. 10,
1926.

41) *Ceratium macroceros* (EHRBG).

* EHRENBURG 1840, p. 201.

OKAMURA and NISHIKAWA 1904, p. 122, Fig. 2.

OKAMURA 1907, p. 129, Pl. IV, Fig. 23.

PAULSEN 1908, p. 81, Fig. 81.

JØRGENSEN 1911, p. 63, Pl. I, Fig. 6; Pl. VII, Figs. 132, 133.

A thin-walled, delicate species common in the summer plankton at
Asamushi.

Dimensions: Length, $430-500\mu$; transdiameter, $55-60\mu$.

Loc. Off Asamushi, Aug. 21, 1926.

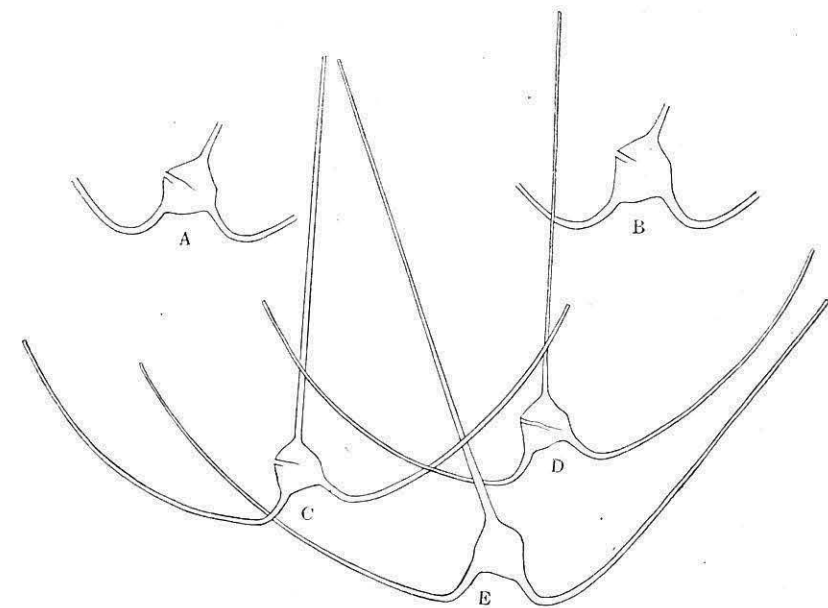


Fig. 44. *Ceratium Macroceros* (EHRBG).

A, B, C, D. ($\times 120$) E, Intermediate form between this and subsp. *gallicum*.
($\times 120$)

42) *Ceratium macroceros* (EHRBG). var. *karsteni*, n. var.

C. tripos macro. EHRBG. var. *crassa* KARSTEN 1907, Pl. XLIX, Fig. 27e.

The mid-body is slightly larger than the preceding and is remarkably

swollen anteriorly, so that the transdiameter at the girdle is shorter than that of the largest part of the pregirdle and the mid-body is somewhat pentagonal in ventral view.

The basal part of the apical horn is thick and gradually tapers distally. The right antapical horn usually curves with a smaller curvature than the preceding. The post-margin is always narrower than the transdiameter at the girdle. The surface is smooth.

Dimensions; Length, 500μ ; transdiameter, 67μ .

Loc. Off Asamushi, Aug. 10, 1926.

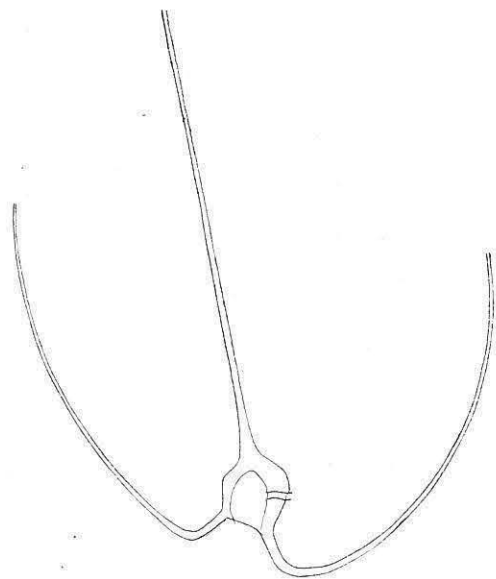


Fig. 45. *Ceratium macroceros* (EHRBG). CLEVE var. *karsteni*, n. var. ($\times 120$)

43) *Ceratium macroceros* (EHRBG.) forma (?)

The post-indentation is much deeper than that of *C. Carriense* f. *ceylanicum* (B. SCER.) Jørg. and *C. tenue* var. *buceros* (ZACHARIAS). Also the girdle lists are complete. The deep post-indentation and the mid-body closely correspond to *C. macroceros*.

Dimensions: Length, 350μ ; transdiameter, 55μ .

Loc. Off Asamushi, Aug. 25, 1926.

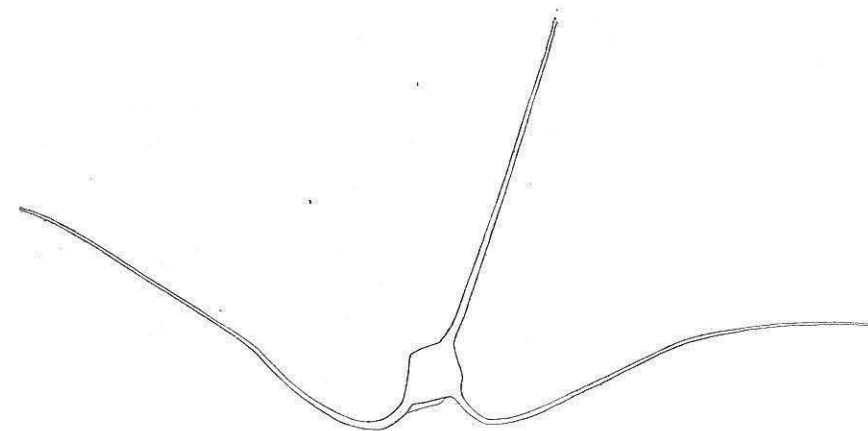


Fig. 46. *Ceratium macroceros* (EHRBG.) forma (?) ($\times 120$)

44) *Ceratium macroceros* subsp. *gallicum* (KOFOLD).

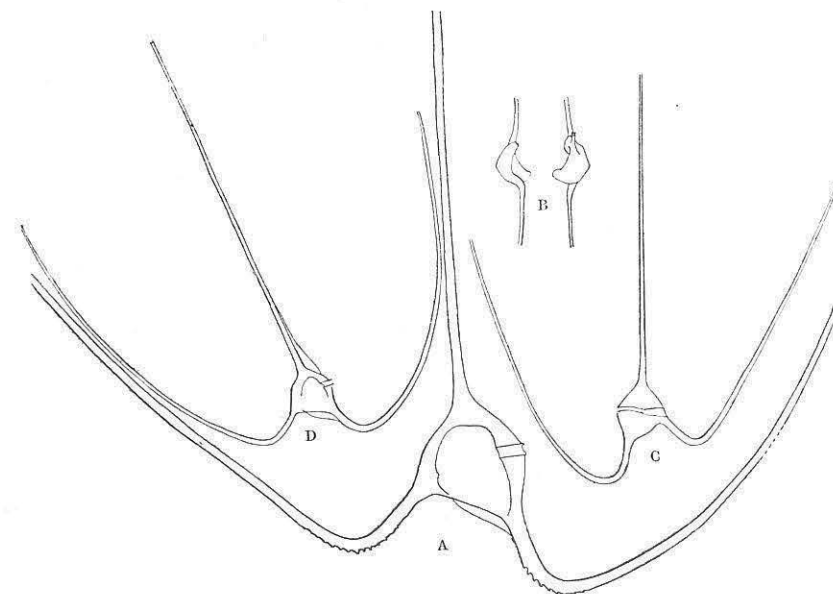


Fig. 47. *Ceratium macroceros* subsp. *gallicum* (KOFOLD).

A, ($\times 300$) B, Apical and antapical view of mid-body. ($\times 120$) C, ($\times 120$) D, A form transitional to *C. macroceros* species. ($\times 120$)

KOFOID 1907, p. 302, Pl. XXIV, Figs. 10-12.

JØRGENSEN 1911, p. 63, Pl. VII, Figs. 134, 135.

FORTI 1922, p. 63, Pl. III, Fig. 48.

This is distinguished from *C. macroceros* mainly by its right antapical horn, sharply bent at a little distance from its proximal end, somewhat intervening a straight part. The mid-body is small with a straight post-margin. There seems to be a tendency, as measurements show, that the narrower the proximal antapical angle, the longer the proximal straight part of the right antapical horn.

Dimensions: Length, 470-615 μ ; transdiameter, 50-68 μ .

Loc. Off Asamushi, Aug. 8, 1926.

45) *Ceratium massiliense* (GOURRET).

JØRGENSEN 1911, p. 66, Pl. VII, Figs. 140, 141, 142.

OKAMURA 1912, p. 9, Pl. I, Fig. 13.

C. trip. var. *massiliense* GOURR. 1883, p. 27, Pl. I, Fig. 2.

C. trip. macroceroides KARSTEN 1906, Pl. XXII, Fig. 28 a. b.

C. trip. macroceros KARSTEN 1906, Pl. XXII, Fig. 29 a.

C. ostenfeldii KOFOID 1907(e), p. 305, Pl. XXVI, Fig. 22-25.

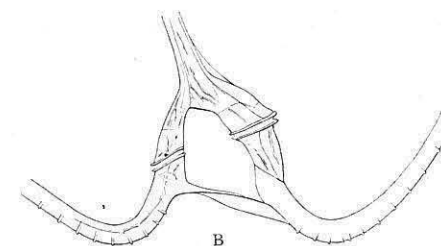
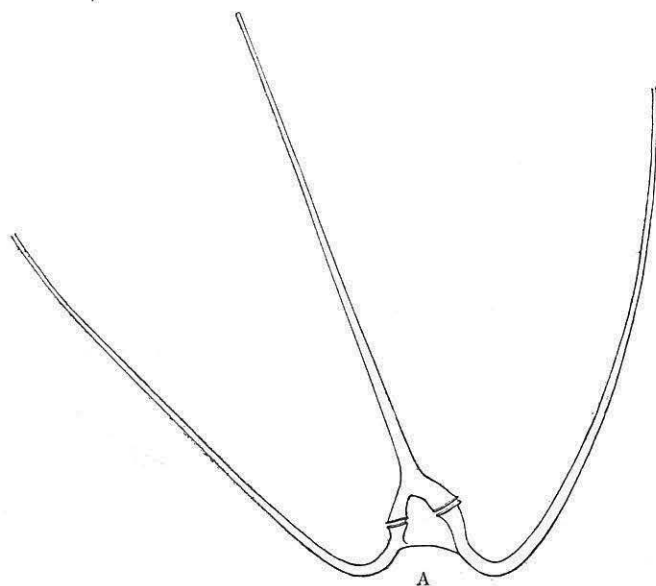


Fig. 48. *Ceratium massiliense* (GOURRET).

A. ($\times 120$) B, Ventral view of mid-body. ($\times 280$)

A stout, spreading species common in late summer plankton at Asamushi, with a thick wall and a wrinkled surface.

Dimensions: Length, 550 μ ; transdiameter 75 μ .

Loc. Off Asamushi, Aug. 20, 1926.

46) *Ceratium trichoceros* (EHRBG).

KOFOID 1908(b), p. 388.

JØRGENSEN 1911, p. 75, Pl. IX, Fig. 159.

* *Peridinium trichoceros* EHRENBURG 1859, p. 791, 1873, p. 3, Fig. I.

C. flagelliferum CLEVE(a) 1900, p. 14, Pl. VII, Fig. 12.

C. tripos flagelliferum KARSTEN 1906, Pl. XXII, Fig. 31b.

C. tripos flagell. forma *crassus* KARSTEN 1906, Pl. XXII, Fig. 32 a, b.

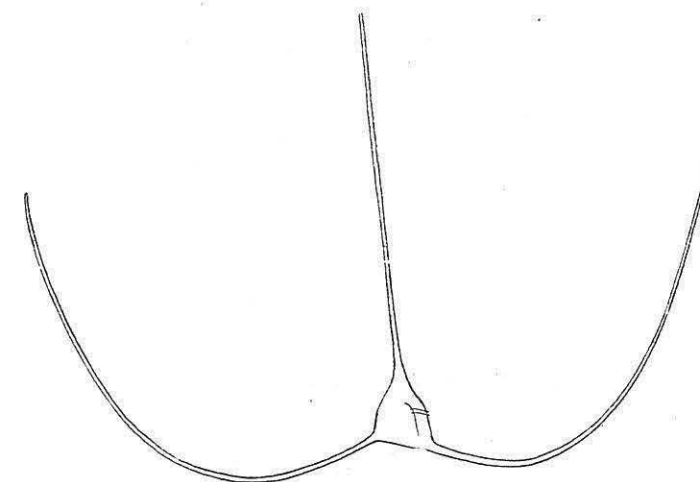


Fig. 49. *Ceratium trichoceros* (EHRBG). ($\times 120$)

The mid-body is tall and triangular and little smaller than that of *C. inflexum*. The basal part of the left antapical horn is delimited from the post-margin.

Dimensions: Length, 400μ ; transdiameter, 54μ .

Loc. Off Asamushi, Aug. 24, 1926.

47) *Ceratium inflexum* (GOURRET).

KOFOID 1908(b), p. 338.

JØRGENSEN 1911, p. 76, Pl. IX, Figs. 160, 161.

C. tripos var. *typicum* GOURRET 1883, p. 31, Pl. II, Fig. 36.

C. flagelliferum var. *filiformis* OKAMURA et NISHIKAWA 1904, p. 123, Pl. VI, Fig. 11.

C. tripos flagell. forma *angulata* KARSTEN 1906, Pl. XXII, Fig. 33.

C. trip. var. *macroceras* forma *undulata* KARSTEN 1907, Pl. XLVII, Fig. 23.

This is distinguished from *C. trichoceros* by its larger, but flat and triangular mid-body.

Dimensions: Length, $350-420\mu$; transdiameter, $54-63\mu$.

Loc. Off Asamushi, Aug. 24, 1926.

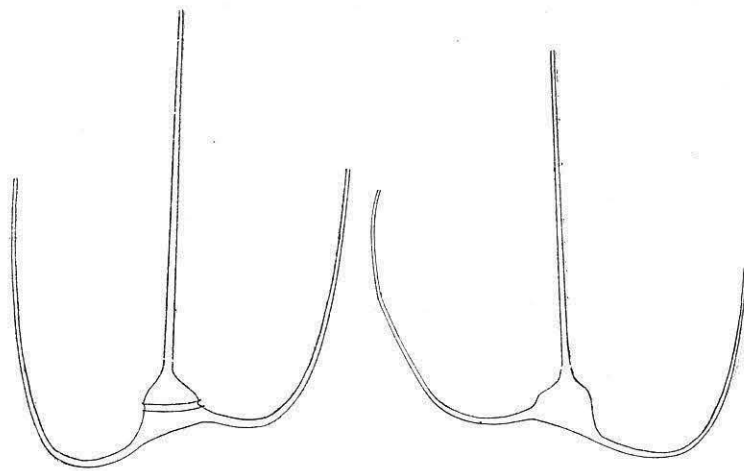


Fig. 50. *Ceratium inflexum* (GOURRET). ($\times 120$)

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